LEVEL 12

RESEARCH AND DEVELOPMENT TECHNICAL REPORT
CORADCOM- 77-C-0489-F

MANUFACTURING METHODS AND TECHNOLOGY PROGRAM FOR LOW COST HYBRID SILICON PHOTODETECTORS MODULES

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FINAL REPORT: JUNE 1, 1977 - DEC. 30, 1979

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AD-A093320

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REF: FINAL REPORT FOR US ARMY CONTRACT NO. DAAB07-77-C-0489 TITLED "MM&T MEASURE FOR LOW COST HYBRID SILICON PHOTODETECTOR MODULES" DATED 79/12/30

Gentlemen: January 22, 1981

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Yours truly,

Thomas Doyle

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: CORADCOM-77-C-0489F	2. GOVT ACCESSION NO.: AD-A093320
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Manufacturing Methods and Technology Program for low cost hybrid silicon photodetector modules. Final Report	5. TYPE OF REPORT & PERIOD COVERED: FINAL June 1, 1977 - Dec. 30, 1979
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): R.H. Buckley, R.E. Cardinal, M.J. Teare, T. Doyle	8. CONTRACT OR GRANT NUMBER(s): DAAB07-77-C-0489
9. PERFORMING ORGANIZATION NAME AND ADDRESS: RCA Limited, 21001 Trans-Canada Highway, Ste-Anne-de-Bellevue, Quebec, Canada H9X 3L3	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2-7697762/8
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Electronic Research and Development Command ATTN: DELSD-D-PC	12. REPORT DATE: Dec. ~~20~~ 1979
	13. NUMBER OF PAGES: 360
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): 9) Final rept. 1 Jun 77- 30 Dec 79	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

AVALANCHE PHOTODIODE MODULES, RANGEFINDER DETECTOR MODULES, FIBRE OPTIC DETECTOR MODULES

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

«SEE PAGE 2 FOR ABSTRACT.»

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT

Two silicon photodiode-amplifier modules have been developed and brought to the stage where moderate production rates have been demonstrated. The first of these is SAPDM-1 built to Specification MMT-769776-2. This unit uses a silicon avalanche photodiode, together with a hybrid preamplifier, in a TO-8 size package and is optimized to detect pulsesof 1.06µm radiation in a rangefinder application. The second module is SAPDM-2 built to specification MMT-769776-3. This unit uses a silicon avalanche photodiode together with a hybrid preamplifier on a special 1'' diameter package for use in fibre optic applications at 820nm. This unit also contains temperature compensation circuitry which keeps the characteristics of the unit constant as the temperature changes.

MANUFACTURING METHODS AND TECHNOLOGY MEASURE

FABRICATION METHODS FOR LOW COST HYBRID

SILICON PHOTODETECTOR MODULES

FINAL REPORT

June 1, 1977 - December 30, 1979

U.S. ARMY CONTRACT # DAAB07-77-C-0489

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RCA ELECTRO OPTICS

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4. ABSTRACT

Two silicon photodiode - amplifier modules have been developed and brought to the stage where moderate production rates have been demonstrated. The first of these is SAPDM-1 built to Specification MMT-769776-2. This unit uses a silicon avalanche photodiode, together with a hybrid preamplifier, in a TO-8 size package and is optimized to detect pulse of 1.06μm radiation in a rangefinder application. The second module is SAPDM-2 built to specification MMT-769776-3. This unit uses a silicon avalanche photodiode together with a hybrid preamplifier on a special 1" diameter package for use in fibre optic applications at 820nm.
8 This unit also contains temperature compensation circuitry which keeps the characteristics of the unit constant as the temperature changes.

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6. Purpose

The purpose of this program is to develop and demonstrate manufacturing methods and documentation adequate to meet the production rates envisaged in the contract. The performance of the contract consists in combining the avalanche photodiode SCS 46¯ in its original or modified version with electronic circuitry in modular form to produce a detector-preamplifier (range finder) and detector preamplifier with temperature compensation (fibre optic receiver), in accordance with the appropriate specifications and quantities.

7. Glossary

None. All quantities are defined as used within the text.

8. Narrative and Data

8.1 Device Description

8.1.1 Intent of the Contract

The purpose of the contract, which was awarded in May 1977, was to develop manufacturing methods and processes for two types of hybrid silicon avalanche photodetector modules. The first of these, the range finder module, has been designated SAPDM-1 by the Army. The module's performance is described in ECOM Technical Requirements MMT-769776-2. RCA has designated the same module commercially as C30944E. Sensitive to 1.06μm radiation and having suitable dynamic range, it incorporated a silicon avalanche photodiode and preamplifier circuit within a TO-8 size optical package. One feature of this device was the necessity for fast recovery from optical overload, such as might result from accidental reflections from near objects. The second module, for use in Fibre Optic Applications, has been designated SAPDM-2 by the Army. The module performance is described in ECOM Technical Requirements MMT-769776-3. RCA describes the fibre optic module, commercially, as the C30941E.

8.1.1 Intent of the Contract (cont'd)

The module incorporates an avalanche photodiode and preamplifier within a package having a light-pipe optical port and is optimized for a fiber optic communications application at 820nm wavelength. In the initial specification, temperature compensation circuitry was to be provided in a separate package which would adjust the bias voltage of the avalanche photodiode in order to maintain the gain constant as the temperature varied.

8.1.2 Logistical Development of the Contract

The contract was divided into three phases, viz,

(i) An engineering phase, comprising two sets of engineering samples (for a total of 10 units of each device).

(ii) A confirmatory samples phase, in which 30 units of each device were manufactured and submitted to full quality testing.

(iii) A pilot production phase in which 100 units of each type were manufactured using processes developed under (i) and employed in (ii). The units were tested according to the sampling plan called for in the contract.

A production rate of 100 units per week was demonstrated and a study of the pilot line requirements was undertaken, with a view to a target rate of 2500 units per week.

The basic concept used in the module preamplifier design was that of the unconditionally stable, sub-unity gain positive feedback amplifier. In this design, the photocurrent develops a voltage across a load resistor, which is applied to the input buffer stage of a common collector amplifier circuit. The output of the buffer is fed back to the high voltage side of the photodiode, neutralizing its capacitance. The bandwidth of the circuit is thus determined by the value of the load resistor and the extent to which the total effective input capacitance can be reduced.

In addition, it was proposed to attempt a mechanical design in which preamplifier and temperature compensation circuitry were jointly hybridized on the same thick film circuit, enabling the SAPDM-2 to be constructed as a single modular unit, apart from external trimming resistors.

As a result of these design approaches, it became necessary to re-evaluate the intention of the original specification and some of the values of important parameters. Also some mechanical difficulties were encountered in the mechanical construction of the modules. The way in which these questions were resolved is presented in subsequent sections, as a chronological narrative, with each principal area of interest discussed separately. The logical starting point is the original specifications for the modules which follow on the succeeding pages.

8.1.2.1 MODULE SPECIFICATIONS (June 1, 1977)
TECHNICAL REQUIREMENTS MMT-769776-2 (77-06-01)

SILICON AVALANCHE PHOTODETECTOR MODULE

FOR RANGEFINDER APPLICATION

1. SCOPE

1.1 Scope

This specification covers the detail requirements for a Silicon Avalanche Photodetector Module (SAPDM1) for the detection of 1060 nanometer (nm) radiation for rangefinder applications.

1.2 Device Class - Device shall be class B as defined in MIL-M-38510.

1.3 Maximum Operating Conditions - V_{cc} = +6V, -6V
V_b = 550V
P_{in} = 75mW

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposals, form a part of this specification to the extent specified herein:

SPECIFICATIONS

FEDERAL

0-E-00760	Ethyl Alcohol (Ethanol); Denatured Alcohol; Proprietary Solvents and Special Industrial Solvents.
0-M-232	Methanol (Methyl Alcohol).
TT-I-735	Isopropyl Alcohol
MMM-A-131	Adhesive, Glass to Metal
MMM-A-134	Adhesive, Epoxy Resin, Metal to Metal Structural Bonding.

MILITARY

MIL-C-675	Coating of Glass Optical Elements
MIL-M-38510	Microcircuits, General Specification for.

OTHER

SCS-467 Solid State Avalanche Detector

STANDARDS

MILITARY

MIL-STD-883 Test Methods and Procedures for Microelectronics

(Copies of specifications, standards, drawing and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both title and number or symbol should be stipulated when requesting copies.)

3. REQUIREMENTS

3.1 Description of SAPDM1 - The SAPDM1 is a high speed, high quantum efficiency device. This module is used for rangefinder applications; in particular for the hand-held range finder AN/GVS-5 and the mini laser range finder AN/PVS-6. This module is a hermetically sealed unit which operates over the temperature range from -50°C to 71°C. It contains a silicon avalanche photodiode and a high speed, low noise amplifier, which has an extremely fast recovery time from high signal inputs. An avalanche multiplication gain control circuit is not incorporated in this module; however, an input is provided to directly bias the avalanche diode.

3.2 Performance Characteristics - Performance characteristics shall be as specified in Tables I, III, IV and V.

3.3 Design, Construction, and Physical Dimensions

The design, construction and physical dimensions shall be as specified in MIL-M-38510 and herein. The following exceptions shall apply to paragraph 3.5.1 of MIL-M-38510:

3.3 (cont'd)

(a) Epo-Tek H20E (Epoxy Technology Inc., Watertown, MA) may be used to mount the chip devices to the substrate of the silicon pin photodetector preamplifier hybrid circuit.

(b) Adhesives conforming to Federal Specifications MMM-A-131 and MMM-A-134 may be used (where applicable) for package sealing.

(c) A Government approved apoxy may be used for attachment of the substrate to the package.

The above exceptions shall apply only if the materials specified are used.

3.3.1 Logic Diagram - The logic diagram shall be as specified on Figure 1.

3.3.2 Case Outline - The case outline shall be in accordance with Figure 2.

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3.3.3 Lead Material and Finish - The lead material shall be Type A and B and lead finish shall be gold plate, per paragraphs 3.5.6.1 and 3.5.6.2 respectively, of MIL-M-38510.

3.3.4 Metals - External metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion.

3.4 Electrical Performance Characteristics - The electrical performance characteristics are as specified in Table I, and apply over the full ambient operating temperature range of $-50^{\circ}C$ to $71^{\circ}C$ unless otherwise specified.

3.5 Rebonding - Rebonding shall be in accordance with paragraph 3.7.1.2 of MIL-M-38510.

3.6 Marking - Marking shall be in accordance with MIL-M-38510 except the following information shall be marked on each microcircuit.

(a) Date Code
(b) Manufacturer's identification
(c) Part Number: MMT-769776-2

3.7 Interchangeability - Any change which affects functional interchange-ability and/or pin to pin replaceability shall require assignment of a new part or type number.

3.8 Window - The window shall contain no stains or cracks over that portion which is in the optical path (area of input radiation incident on the silicon avalanche photodiode chip). The center portion of the window shall have a 0.150 inch minimum diameter and be free from optical distortion and lens effects. The window may be anti-reflection coated on both surfaces for a λ = 1060nm.

3.9 Resistance to solvents - When the device is subjected to solvents, there shall be no evidence of: (a) mechanical damage, (b) deterioration of the materials or finishes, and (c) illegibility of case marking.

3.10 Bond Strength - The bond shall meet the minimum bond strength requirements listed in Table I of method 2011 of MIL-STD-883.

3.11 Solderability - All electrical terminals shall be solderable.

3.12 Lead Integrity - With a force of 8 ounces applied to the leads for three 90 ± 5 degree arcs of the case, there shall be no evidence of breaking.

3.13 Seal - For fine leak, the maximum allowable leakage rate shall not exceed $5x10^{-7}$ atm cc/sec. For gross leak, the maximum allowable leakage rate shall not exceed $1x10^{-3}$ atm cc/sec.

3.14 Thermal Shock - After being subjected to specified temperature conditioning, there shall be no evidence of defects or damage to case, leads, or seals or loss of marking legibility.

3.15 Temperature Cycling - After being subjected to specified temperature cycling, there shall be no evidence of defects or damage to case, leads or seals or loss of marking legibility.

3.16 Mechanical Shock - After being subjected to a shock of 1500g for 0.5 msec, there shall be no evidence of defects or
19 damage to leads or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.17 Vibration - After being subjected to a vibration with a peak acceleration of 20g with a frequency range of 20 to 2000Hz, there shall be no evidence of defects or damage to case, leads or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.18 Constant Acceleration - After being subjected to a constant acceleration of 5000g for 1 minute in each of its orientations, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.19 High Temperature Storage - After being stored at a temperature of 85°C four 24 hours, the device shall be electrically operable (see 4.6.3(a)).

TABLE I.- ELECTRICAL PERFORMANCE CHARACTERISTICS 1/

CHARACTERISTIC	SYMBOL	CONDITIONS	LIMITS Min	Max	UNITS
Responsivity	R	λ=1060nm	$1.3x10^5$		V/W
Spectral Output Noise Voltage Density	V_n	Δf=100 KHz (a) f=10MHz (b) f=20,30,and 40 MHz		 $3.6x10^{-8}$ $6.0x10^{-8}$	$V/(Hz)^{1/2}$
Output Swing	V		1		V
Bandwidth	BW	3dB points	$20x10^6$		Hz
Frequency Response Deviation	Δf_r	f> 10KHz f< 70KHz	-40%	+20%	
Recovery Time	t_{rev}	P_{opt}=500mW,5ns	660		ns
Rise Time	t_r		18		ns
Fall Time	t_f		18		ns
Power Consumption	P_{in}			75	mW
Output Impedance	Z_o	f=1MHz		50	ohms
Dynamic Range	DR		40		db

1/ The following conditions apply to all performance characteristics in Table I: V_b is adjusted to obtain $R \geqslant 1.3x10^5$ V/W with V_{cc} = +6V, -6V.

3.20 Operating Life - After being operated at 71°C for 1000 hours under normal operating conditions, the device shall be electrically operable (see 4.6.3(a)).

3.21 Moisture Resistance - After being subjected to the specified humidi. and temperature cycling, there shall be no evidence of corrosion of external metal surfaces. Also, the device shall be electrically operable (see 4.6.3(a)).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection:- Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of Inspection - Inspection shall be classified as follows:

(a) First article inspection (does not include preparation for delivery). (see 4.5).

(b) Quality Conformance Inspection. (See 4.6).

4.3 Test Plan - The contractor prepared Government-approved test plan, as cited in the contract, shall contain:

(a) Time schedule and sequence of examinations and tests.

(b) A description of the method of test and procedures.

(c) Identification and brief description of each inspection instrument and date of most recent calibration.

4.4 Screening - Screening shall be conducted on all devices prior to first article and quality conformance inspection and shall be in accordance with Class B of Method 5004 of MIL-STD-883. The following additional criteria shall apply:

(a) Internal visual per Method 2017 of MIL-STD-883
(b) Stabilization bake per Method 1008 except temperature shall be $85^{o}C$
(c) Thermal shock (Method 1011 of MIL-STD-883 Condition A).
(d) Temperature cycling per Method 1010, Test Condition A, of MIL-STD-883.
(e) Mechanical shock shall be in accordance with MIL-STD-883 Method 2002, Condition B except there will be 2 shocks per orientation (12 shocks total) with a duration of 0.5msec.
(f) Constant acceleration per Method 2001, Test Condition A, of MIL-STD-883.
(g) Seal (Method 1014 of MIL-STD-883
  (1) Fine leak: per Test Condition A_1.
  (2) Gross Leak: per Test Condition C_1.
(h) Interim (Pre-Burn-in) electrical parameters shall consist of subgroup 1 of Table III.
(i) Burn-in (Method 1015 of MIL-STD-883).
  (1) Test Condition B.
  (2) $T_a=71^{o}C$ minimum.
(j) Interim (post burn-in) electrical parameters shall consist of subgroup 1 of Table III.
(k) Reverse bias burn-in and interim electrical test in accordance with 3.1.10 of Method 5004 of MIL-STD-883 may be omitted.
  (1) Omit "Final Electrical Test" screen.

4.5 First Article - Unless otherwise specified in the contract, the first article inspection shall be performed by the contractor.

4.5.1 First Article Units. - The contractor shall furnish 30 samples.

4.5.2 First Article Inspection - The first article inspection shall consist of Table II and all the tests included in the Government-approved test plan to show compliance with the requirements of Section 3. No failures shall be permitted.

4.6 Quality Conformance Inspection - Quality Conformance Inspection shall consist of tests specified in Tables III, IV and V.

4.6.1 Group A Inspection - Group A inspection shall consist of Table III.

4.6.2 Group B Inspection - Group B inspection shall consist of Table IV, and as follows:

(a) Units subjected to subgroup 2 shall be used for subgroup 3.
(b) Window (See 4.7.1).

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4.6.3 Group C Inspection - Group C inspection shall consist of Table V and as follows:

(a) End point electrical parameters shall consist of subgroups 1, 4, and 7 of Table III.
(b) Operating life test: The module shall be operated with the voltages used in performing tests on subgroups 1,2,4,7, and 8 (see Table III) and with a P_{opt} of 1 μW minimum.

4.7 Method of Examination and Test - Methods of examination and test shall be as specified in the appropriate tables and as follows:

4.7.1 Window - A visual inspection shall be made to insure there are no cracks or optical distortions in the window. The anti-reflection coating, if used, shall conform to the abrasion resistance requirement of MIL-C-675. These tests shall be performed prior to attaching the window to the case. (See 3.8).

TABLE II.- FIRST ARTICLE INSPECTION

TEST	METHOD	No. of SAMPLES 2/				
		3	5	5	7	10
Group A Inspection	Table III 1/	TO BE PERFORMED ON ALL UNITS				
Group B Inspection	Table IV 1/					
Subgroup 1		X				
Subgroup 2		X				
Subgroup 3		X				
Subgroup 4		X				
Group C Inspection	Table V 1/					
Subgroup 1					X	
Subgroup 2			X			
Subgroup 3				X		
Subgroup 4						X

1/ LTPD values do not apply for first article inspection.

2/ The number of samples specified for each column shall be subjected to all the tests of that column.

TABLE III.- GROUP A ELECTRICAL TEST

MIL-STD-883 Method 5005 Table I Subgroup	Symbol	Test Method	Max	Min	LTPD
1	V_n	Para.4.7.2.2 (a) f=10MHz (b) f=20,30,and40MHz	 $3.6x10^{-8}V/(Hz)^{½}$ $6.0x10^{-8}V/(Hz)^{½}$		
static 25°C					13
1	P_{in}	Para.4.7.2.8	75 mW		
1	Z_o	Method 4005 of MIL-STD-883	50 ohms		
2	V_n	Para.4.7.2.2 (at 10MHz only)	$1.2x10^{-7}V/(Hz)^{½}$		
2 static 71°C	P_{in}	Para.4.7.2.8	75 mW		20
2	Z_o	Method 4005 of MIL-STD-883	50 ohms		
4	V_{out}	Para.4.7.2.3		1V	
4 25°C	BW	Para.4.7.2.4		$20x10^6$Hz	13
4	Δf_r	Para.4.7.2.5	+20%	-40%	
4	t_{rev}	Para.4.7.2.9	660ns		
4	DR	Para.4.7.2.6		40db	
7	R	Para.4.7.2.1		$1.3x10^5$V/W	
7 25°C	t_r	Para.4.7.2.7	18ns		13
7	t_f	Para.4.7.2.7	18ns		
7	V_n	Para.4.7.2.2 (at 10MHz only)	$3.6x10^{-8}V/(Hz)^{½}$		
8	R	Para.4.7.2.1		$1.3x10^5$V/W	
8 71°C,-50°C	t_r	Para.4.7.2.7	18ns		24
8	t_f	Para.4.7.2.7	18ns		
8	V_n	Para.4.7.2.2 (at 10MHz only)	$1.2x10^{-7}V/(Hz)^{½}$		

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TABLE IV.- GROUP B TESTS 1/

TEST	REQT PARA	MIL-STD-883 METHOD	MIL-STD-883 CONDITION	Class B LTPD
Subgroup 1				
Physical dimensions	3.3.2	2009		36
Window (see 4.7.1.)	3.8			
Subgroup 2				
(a) Resistance to solvents	3.9	2015	See 4/	3 devices (no failures)
(b) Internal visual and mechanical	3.3	2014		1 device (no failure)
(c) Bond strength 2/	3.10	2011		36
(1) Thermocompression			(1) Test Condition C or D	
(2) Ultrasonic or wedge			(2) Test Condition C or D	
(3) Flip-Chip			(3) Test Condition F	
(4) Beam Leak			(4) Test Condition H	
Subgroup 3				
Solderability 3/	3.11	2003	Soldering temperature of 260 ± 10°C	36
Subgroup 4				
Leak Integrity	3.12	2004	Test Condition B_2, lead fatigue	36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	

1/ Electrical reject devices from the same inspection lot may be used for all subgroups.

2/ Unless otherwise specified, at the manufacturer's option, test samples for bond strength may be selected randomly immediately following internal visual (Method 5004) prior to sealing.

3/ All devices must have been through the temperature/time exposure in burn-in. The LTPD applies to the number of leads inspected except in no case shall less than three devices be used to provide the number of leads required.

4/ Except solvents used shall be: (a) Methyl Alcohol, per 0-M-232, Grade A, (b) Ethyl alcohol, per 0-E-00760, Type 1, Grade A, (c) Isopropyl Alcohol, per TT-I-735, Grade A, and (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) and one (1) part by volume of distilled water.

4.7.2 Electrical

4.7.2.1 Responsivity (R) - A Gallium Indium Arsenide (GaInAs) LED (λ=1060nm ± 5nm) shall be used to measure the responsivity. The GaInAs diode's power output shall be calibrated to obtain a given power density at optical input port. A pulse width of 50 ns will be used for the measurement. The rise and fall time of the source shall be less than 6ns. The peak output of the module will then be measured. The responsivity shall be defined as the ratio of the output voltage (V_{out}) of the module to the power incident on the detector (P_{opt}). The output of the module shall be terminated in a 50 ohms load for this measurement.

4.7.2.2 Spectral Output Noise Voltage Density (V_n) The output noise voltage shall be measured at center frequencies of 10,20,30 and 40MHz with Δf=100KHz or less. (The spectral output noise voltage density shall be defined as the ratio of output noise voltage to the square root of the bandwidth($\sqrt{BW}$). (See 4.7.2.4). The output of the module will be terminated in a 50 ohm load for this measurement.

4.7.2.3 Output Swing(V_S) - The voltage output of the module shall be measured with the optical input port covered. Then, an optical input of power corresponding to the upper power limit of linearity (see 4.7.2.6) shall be applied to the optical input port and the output voltage measured. The difference in these two output voltage readings shall be defined as the output swing.

TABLE V.- GROUP C TESTS

TEST	REQT PARA	MIL-STD-883 METHOD	CONDITION	CLASS B LTPD
Subgroup 1 1/				
Thermal Shock	3.14	1011	Test Condition A as a min.	
Temperature Cycling	3.15	1010	Test Condition A	
Moisture Resistance	3.3.4.3.21	1004		36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	
Visual Examination 2/	3.3			
End point electrical parameters (see 4.6.3(a))				
Subgroup 2 1/				
Mechanical Shock	3.16	2002	Test Condition B	
Vibration, variable frequency	3.17	2007	Test Condition A	
Constant Acceleration	3.18	2001	Test Condition A	36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	
Visual Examination 3/	3.3			
End Point Electrical parameters (see 4.6.3(a))				
Subgroup 3				
High Temperature 4/ storage	3.19	1008	$T_a = 85^{\circ}C$ for 24 hours	24
End Point Electrical parameters (see 4.6.3(a))				
Subgroup 4				
Operating life 4/ (see 4.6.3(b))	3.20	1005	Test Condition B at $71^{\circ}C$	20
End Point Electrical Parameters (see 4.6.3(a))				

1/ Devices used for environmental tests in subgroup 1 may be used for mechanical tests in subgroup 2.

2/ Visual examination shall be in accordance with method 1010 or 1011 at a magnification of 5X to 10X.

3/ Visual examination shall be performed at a magnification of 5X to 10X for evidence of defects or damage to case, leads, or seals resulting from testing (not fixturing). Such damage shall constitute a failure.

4/ See 40.4 of appendix B of MIL-M-38510.

4.7.2.4 Module Bandwidth (BW) - A sinusoidal wave modulated LED (wavelength of 1060nm ± 5nm) shall be operated such that the power on the module's detector is within the linear operating range. (See 4.7.2.6). The output of the module will be monitored as the frequency of modulation of the source is varied. The bandwidth will be defined as the difference in lower and upper frequencies corresponding to an output voltage reduction of 3db from output at 100KHz. The source should supply a constant power output, with a fixed modulation index (see 6.3).

4.7.2.5 Frequency Response Deviation (Δf_r) - With the
29 optical input port uncovered, a p_{opt} of 1μw shall be applied. R shall then be measured (see 4.7.2.1) at 10KHz, 1 MHz, 20MHz, 30MHz, and 40MHz. The respective Δf_r can then be calculated. (See 6.4).

4.7.2.6 Dynamic Range (DR) - The power of the modulated source, incident on the detector, shall be varied by controlling the drive current. That point at which the module output deviates from linearity (with respect to the input power) by more than 25%, will be defined as the upper power limit in linearity. The lower limit shall be taken as the NEP x $\sqrt{BW}$, where BW=20MHz (See 6.2). The difference resulting from the upper power limit minus the lower power limit shall be defined as the dynamic range (in db). This measurement shall be done with a 50ns pulse width and repetition rate of 1MHz or less.

4.7.2.7 Rise and Fall Time (t_r, t_f) - The rise and fall fall time shall be measured using a GaInAs LED (λ=1060nm ± 5nm) with a rise and fall time of less than 5ns and a minimum pulse width of 50ns. The rise time of the module shall be measured from the 10% to 90% point and fall time from the 90% to 10% point.

4.7.2.8 Power Consumption (P_{in}) - The normal operating voltage shall be applied to the module. The temperature of the module shall be varied over the operating range (-50°C to 71°C) and the input currents shall be monitored to insure that the power input does not exceed the value given by P_{in} = $(i_n V_{cc} + i_n V_b)$ = 75mW. This test shall be performed with the optical port covered.

4.7.2.9 Recovery time (t_{rev}) - The SAPDM1 shall be biased with the proper operating voltages, and the avalanche photodiode shall be biased to insure that the responsivity is greater than 1.3×10^5V/W. An optical input of λ=1060 nm with a minimum peak power of .5W and a maximum pulse width of 5ns shall be incident on the avalanche detector in the SAPDM1. A second optical pulse of maximum amplitude 1 μW and a maximum pulse width of 5ns shall be incident on the avalanche detector within 660ns after the end of the initial pulse. The output of the SAPDM1 shall be connected to a suitable oscilloscope and the display photographed. The display must include both the output from the initial pulse (.5W min) and the output of the second pulse(1μW max).

5 PREPARATION FOR DELIVERY

5.1 Preservation, Packaging and Packing - Units shall be prepared for delivery as specified in the contract.

6 NOTES

6.1 Abbreviations, Symbols, and Definitions - The abbreviations, symbols, and definitions are as follows:

A	Photodetector active area
BW	Bandwidth
DR	Dynamic Range
Δf	Bandwidth used in noise measurement
f	Frequency
Δf_r	Frequency Response Deviation
i_n	Input Current
LED	Light Emitting Diode
m	Modulation Index
NEP	Noise Equivalent Power
P_{av}	Average Optical Input Power
P_{in}	Power Consumption
P_{opt}	Optical Input Power
R	Responsivity
t_f	Fall time
t_r	Rise time
t_{rev}	Recovery time
V_b	Photodetector Bias Voltage
V_{cc}	Amplifier Operating Voltage
V_n	Spectral Output Noise Voltage Density
V_{out}	Voltage Output Swing
λ	Wavelength
Z_o	Output Impedance
V_s	Voltage Output Swing

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6.2 Noise Equivalent Power - NEP is defined as follows:

$$NEP = V_n/R$$

6.3 Modulation Index (m) - The modulation index is defined for cosinusoidal modulation at a radian frequency ω_m by

$$P_{opt} = P_{av}(1 + m \cos \omega_m t)$$

6.4 Calculation of Δf_r -

$$\Delta f_r = \frac{\{R(1MHz).fr(f)\}-R(f)}{R(1MHz).fr(f)}$$

where : R(1MHz) = measured responsivity at 1 MHz

R(f) = measured responsivity at specified frequency f

and, $f_r(f) = \{1+(\frac{f}{BW})^2\}^{-\frac{1}{2}}$

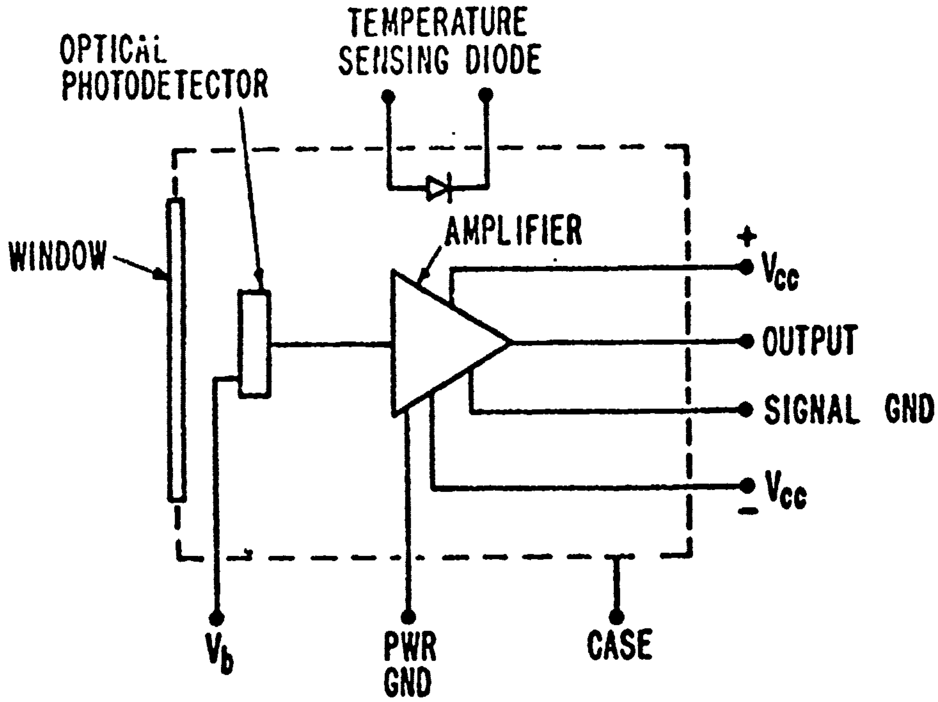
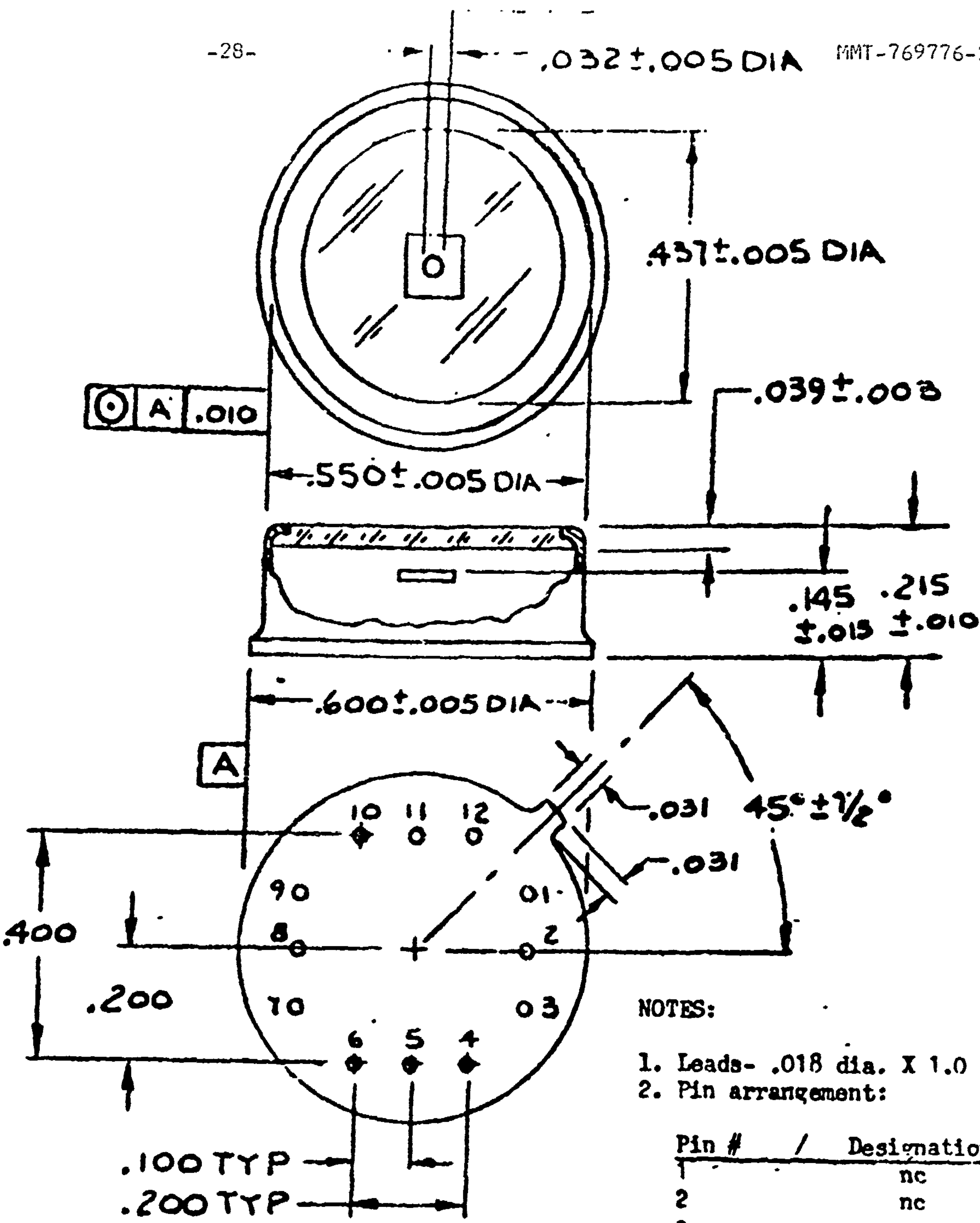


FIGURE 1. LOGIC DIAGRAM FOR PHOTODETECTOR MODULE



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NOTES:

1. Leads- .018 dia. X 1.0 lg.
2. Pin arrangement:

Pin # /	Designation
1	nc
2	nc
3	nc
4	nc
5	V_{out}
6	case ground
7	$-V_{cc}$
8	nc
9	signal ground
10	nc
11	V_b
12	$+V_{cc}$

FIGURE 2. Physical dimensions.

SILICON AVALANCHE PHOTODETECTOR MODULE TECHNICAL REQUIREMENTS MMT-769776-3 (77-06-01) FOR FIBER OPTIC COMMUNICATIONS

1. SCOPE

1.1 Scope - This specification covers the detail requirements for a Silicon Avalanche Photodetector Module(SAPDM2) for the detection of 820 nanometer (nm) radiation for fiber optic communication.

1.2 Device Class - Device shall be class B as defined in MIL-M-38510.

1.3 Maximum operating conditions - V_{cc} = +6V, -6V

V_b = 550V

P_{in} = 100mW

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposals, for a part of this specification to the extent specified herein:

SPECIFICATIONS

FEDERAL

0-E-00760	Ethyl Alcohol(Ethanol);Denatured Alcohol; Proprietary Solvents and Special Industrial Solvents.
0-M-232	Methanol(Methyl Alcohol).
TTOI-735	Isopropyl Alcohol
MMM-A-131	Adhesive, Glass to Metal
MMM-A-134	Adhesive, Epoxy Resin, Metal to Metal Structural Bonding.

MILITARY

MIL-C-675	Coating of Glass Optical Elements
MIL-R-10509	Resistor, Fixed Film, (High Stability) General Specification for.
MIL-M-38510	Microcircuits, General Specification for.
MIL-C-39102	Connector, Coaxial, RF, General Specification for.

OTHER

MMT-769776-1	Silicon Pin Photodetector Module for Fiber Optic Communications.
SCS-467	Solid State Avalanche Detector.

STANDARDS

MILITARY

MIL-STD-883	Test Methods and Procedures for Micro-Electronics.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both title and number or symbol should be stipulated when requesting copies).

3 REQUIREMENTS

3.1 Description of SAPDM2 - SAPDM2 is a high speed, high quantum efficiency device. This module is used for long distance fiber optic communications. This module is a hermetically sealed unit which operates over the temperature range from -50°C to 71°C. It contains a silicon avalanche photodiode and a high speed, low noise amplifier. The two external resistors which control responsivity are to be provided. The SAPDM2 has an optical input connector (identical to that of the pin photodetector module for fiber optic communication. MMT-769776-1) with a numerical aperture (N.A.) greater than 0.3. All radiation at the optical input of the optical connector within a cone of half angle of 17° will be incident on the photodetector. The silicon avalanche photodiode is optimized for a wavelength of 820nm radiation.

3.2 Performance Characteristics - Performance characteristics shall be as specified in Tables I, III, IV and V.

3.3 Design, Construction, and Physical Dimensions - The design, construction and physical dimensions shall be as specified in MIL-M-38510 and herein. The following exceptions shall apply to paragraph 3.5.1 of MIL-M-38510:

(a) Epo-Tek H20E (Epoxy Technology Inc., Watertown, MA) may be used to mount the chip devices to the substrate of the silicon pin photodetector-preamplifier hybrid circuit.

(b) Adhesives conforming to Federal Specifications MMM-A-131 and MMM-A-134 may be used (where applicable) for package sealing.

(c) A Government approved epoxy may be used for attachment of the substrate to the package.

The above exceptions shall apply only if the materials specified are used.

3.3.1 Logic Diagram - The logic diagram shall be as specified on Figure 1.

3.3.2 Case Outlines - The case outlines shall be in accordance with Figures 2 and 3. The connector shall be a MIL-C-39012/61 receptacle modified to incorporate an optical pipe and detector either as shown in Figure 2A or in a modification submitted by the contractor for Government approval. The connector, when incorporated in the photodetector modules, shall have no adverse effect on the performance of the modules as specified.

3.3.3 Lead Material and Finish - The lead material shall be Type A or B and lead finish shall be gold plate, per paragraphs 3.5.6.1 and 3.5.6.2, respectively, of MIL-M-38510.

3.3.4 Metals - External metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion.

3.3.5 External Resistors - The two external resistors which control the temperature compensated biasing circuit (TCU) (See Fig. 1) shall be supplied with the SAPDM2, and when used with any TCU, they shall provide the appropriate responsivity (see Tables I & III). They shall conform to MIL-R-10509.

3.4 Electrical Performance Characteristics - The electrical performance characteristics are as specified in Table I, and apply over the full ambient operating temperature range of $-50^{\circ}C$ to $71^{\circ}C$ unless otherwise specified.

3.5 Rebonding - Rebonding shall be in accordance with paragraph 3.7.1.2 of MIL-M-38510.

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3.6 Marking - Marking shall be in accordance with MIL-M-38510 except the following information shall be marked on each microcircuit.

(a) Date Code
(b) Manufacturer's identification
(c) Part number: MMT-769776-3
(d) Specified values of external resistors, R_1 and R_2.

3.7 Interchangeability - All modules and their specified external resistors (see 3.3.5), having the same manufacturer's part number, shall be interchangeable with each other with respect to fit, form and function.

3.8 Anti-Reflection Coating - The detector and light pipe shall be anti-reflection coated to insure a maximum transmission for λ= 820nm.

3.9 Resistance to Solvents - When the device is subjected to solvents, there shall be no evidence of: (a) mechanical damage, (b) deterioration of the materials or finishes, and (c) illegibility of case marking.

3.10 Bond Strength - The bond shall meet, the minimum bond strength requirements listed in Table I of method 2011.1 of MIL-STD0883.

3.11 Solderability - All electrical terminations shall be solderable.

3.12 Lead Integrity - With a force of 8 ounces applied to the leads for three 90 ±5 degree arcs of the case, there shall be no evidence of breaking.

3.13 Seal - For fine leak, the maximum allowable leakage rate shall not exceed 5×10^{-7} atm cc/sec. For gross leak, the maximum allowable leakage rate shall not exceed 1×10^{-3} atm cc/sec.

3.14 Thermal Shock - After being subjected to specified temperature conditioning, there shall be no evidence of defects or damage to case, leads, or seals or loss of marking legibility.

3.15 Temperature Cycling - After being subjected to specified temperature cycling, there shall be no evidence of defects or damage to case, leads, or seals or loss of marking legibility.

3.16 Mechanical Shock - After being subjected to a shock of 1500g for 0.5msec, there shall be no evidence of defects or damage to leads or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.17 Vibration - After being subjected to a vibration with a peak acceleration of 20g with a frequency range of 20 to 2000Hz, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.18 Constant Acceleration - After being subjected to a constant acceleration of 5000g for 1 minute in each of its orientations, there shall be no evidence of defects or damage to case, leads or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.19 High Temperature Storage - After being stored at a temperature of 85°C for 24 hours, the device shall be electrically operable (see 4.6.3(a)).

3.20 Operating Life - After being operated at 71°C for 1000 hours under normal operating bias conditions, the device shall be electrically operable (see 4.6.3(a)).

3.21 Moisture Resistance - After being subjected to the specified humidity and temperature cycling, there shall be no evidence or corrosion of external metal surfaces. Also, the device shall be electrically operable (see 4.6.3(a)).

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TABLE 1.- ELECTRICAL PERFORMANCE CHARACTERISTICS 1/

Characteristic	Symbol	Conditions	Limits Min	Limits Max	Units
Responsivity	P	λ=820nm	6.5×10^5		V/W
Spectral Output NoiseVoltage	V_n	Δ_f=100KHz (a) f=1MHz (b) f=16,32 and 48MHz		 2.5×10^{-8} 5.0×10^{-8}	$V/(Hz)^{1/2}$
Output Swing	V_{out}		1		V
Bandwidth	BW	3dB points	1.6×10^7		Hz
Frequency Response Deviation	Δf_r	f< 50MHz f> 1KHz	-40%	+20%	
Dynamic Range	DR		40		db
Rise Time	t_r			22	ns
Fall Time	t_f			22	ns
Power Consumption	P_{in}			100	mW
Output Impedance	Z_o	f=1MHz		50	ohms

1/ The following conditions apply to all performance characteristics in Table I: V_b is adjusted to obtain $R>6.5\times10^5$ V/W with V_{cc}=+6V,-6V

4 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection - Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of Inspection - Inspection shall be classified as follows:

(a) First article inspection (does not include preparation for delivery). See 4.5).

(b) Quality conformance inspection. (See 4.6).

4.3 Test Plan - The contractor prepared Government-approved test plan, as cited in the contract, shall contain:

(a) Time schedule and sequence of examinations and tests.

(b) A description of the Method of test and procedures.

(c) Identification and brief description of each inspection instrument and date of most recent calibration.

4.4 Screening - Screening shall be conducted on all devices prior to first article and quality conformance inspection and shall be in accordance with Class B of Method 5004 of MIL-STD-883. The following additional criteria shall apply:

(a) Internal visual per Method 2017 of MIL-STD-883

(b) Stabilization bake per Method 1008 except temperature shall be 85°C.

4.4 Screening - Cont'd

(c) Thermal shock (Method 1011 of MIL-STD-883 Condition A),

(d) Temperature cycling per Method 1010, Test Condition A of MIL-STD-883.

(e) Mechanical shock shall be in accordance with MIL-STD-883, Method 2002, Condition B except there will be 2 shocks per orientation (12 shocks total) with a duration of 0.5msec.

(f) Constant acceleration per Method 2001, Test Condition A, of MIL-STD-883.

(g) Seal (Method 1014 of MIL-STD-883).

(1) Fine Leak: per Test Condition A_1.

(2) Gross Leak: per Test Condition C_1.

(h) Interim (pre-burn-in)electrical parameters shall consist of subgroup 1 of Table III.

(i) Burn-in(Method 1015 of MIL-STD-883).

(1) Test Condition B.

(2) $T_a = 71^{\circ}C$ minimum.

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(j) Interim (post-burn-in) electrical parameters shall consist of subgroup 1 of Table III.

(k) Reverse bias burn-in and interim electrical test in accordance with 3.1.10 of Method 5004 of MIL-STD-883 may be omitted.

(1) Omit "Final Electrical Test" screen.

4.5 First Article - Unless otherwise specified in the contract, the first article inspection shall be performed by the contractor.

4.5.1 First Article Units - The contractor shall furnish 30 samples.

4.5.2 First Article Inspection - The first article inspection shall consist of Table II and all the tests included in the Government-approved test plan to show compliance with the requirements of Section 3. No failures shall be permitted.

4.6 Quality Conformance Inspection - Quality conformance inspection shall consist of tests specified in Tables III, IV and V.

4.6.1 Group A Inspection - Group A inspection shall consist of Table III.

4.6.2 Group B Inspection - Group B inspection shall consist of Table IV, and as follows:

(a) Units subjected to subgroup 2 shall be used for subgroup 3.
(b) Interchangeability (see 4.7.1)
(c) Anti-Reflection coating (4.7.2)

4.6.3 Group C Inspection - Group C inspection shall consist of Table V and as follows:

(a) End point electrical parameters shall consist of subgroups 1, 4 and 7 of Table III.
(b) perating life test: The module shall be operated with the voltages used in performing tests on subgroups 1,2,4,7 and 8 of Table III and with a P_{opt} of µW minimum.

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4.7 Methods of Examination and Test - Methods of examination and test shall be as specified in the appropriate tables and as follows:

4.7.1 Interchangeability - The module shall mate with the specified fiber optic connector. (See Figure 3).

4.7.2 Anti-reflection Coating - The coating shall conform to the abrasion resistance requirement of MIL-C-675. This test shall be performed on the light pipe prior to final assembly of the module.

TABLE II.- FIRST ARTICLE INSPECTION

TEST	METHOD	NO. OF SAMPLES 2/				
		3	5	5	7	10
Group A Inspection	Table II 1/	TO BE PERFORMED ON ALL UNITS				
Group B Inspection	Table III 1/					
Subgroup 1		X				
Subgroup 2		X				
Subgroup 3		X				
Subgroup 4		X				
Group C Inspection	Table IV 1/					
Subgroup 1					X	
Subgroup 2			X			
Subgroup 3				X		
Subgroup 4						X

1/ LTPD values do not apply for first article inspection.

2/ The number of samples specified for each column shall be subjected to all the tests of that column.

TABLE III.- GROUP A ELECTRICAL TEST

MIL-STD-883 Table I Method 5005 Subgroup	SYMBOL	TEST METHOD	MAX	MIN	LTPD
1	V_n	Para 4.7.3.2			
		(a) f=1MHz	$2.5x10^{-8}V/(Hz)^{½}$		
		(b) f=16,32 and 48 MHz	$5.0x10^{-8}V/(Hz)^{½}$		
Static 25°C					13
1	P_{in}	Para 4.7.3.8	100mW		
1	Z_o	Method 4005 of MIL-STD-883	50 ohms		
2	V_n	Para 4.7.3.2 (at 1 MHz only)	$14x10^{-8}V/(Hz)^{½}$		
Static 71°C					
2	P_{in}	Para 4.7.3.8	100 mW		20
2	Z_o	Method 4005 of MIL-STD-883	50 ohms		
4	V_{out}	Para 4.7.3.3		1V	
4	BW	Para 4.7.3.4		$1.6x10^7$Hz	
25°C					13
4	Δf_r	Para 4.7.3.5	+20%	-40%	
4	DR	Para 4.7.3.6		40db	
7	R	Para 4.7.3.1		$6.5x10^5$V/W	
7 (25°C)	t_r	Para 4.7.3.7	22ns		
7	t_f	Para 4.7.3.7	22ns		13
7	V_n	Para 4.7.3.2 (at 1MHz only)	$2.5x10^{-8}V/(Hz)^{½}$		
8	R	Para 4.7.3.1		$6.5x10^5$V/W	
8	t_r	Para 4.7.3.7	22ns		
71°C,-50°C					24
8	t_f	Para 4.7.3.7	22ns		
8	V_n	Para 4.7.3.2 (at 1MHz only)	$14x10^{-8}V/(Hz)^{½}$		

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TABLE IV.- GROUP B TESTS 1/

TEST	REQT PARA	MIL-STD-883 METHOD	CONDITION	CLASS B LTPD
Subgroup 1				
Physical dimensions	3.3.2	2009		
Interchangeability (see 4.7.1)	3.7			36
Anti-reflection coating (see 4.7.2)	3.8			
Subgroup 2				
(a) Resistance to solvents	3.9	2015	see 4/	3 devices (no failure)
(b) Internal visual and mechanical	3.3	2014	see 4/	1 device (no failure)
(c) Bond strength 2/	3.10	2011		36
(1) Thermocompression			(1) Test Condition C or D	
(2) Ultrasonic or wedge			(2) Test Condition C or D	
(3) Flip-Chip			(3) Test Condition F	
(4) Beam Lead			(4) Test Condition H	
Subgroup 3				
Solderability 3/	3.11	2003	Soldering temperature of 260 ± 10°C	36
Subgroup 4				
Lead integrity	3.12	2004	Test Condition B_2, lead fatigue	36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	

1/ Electrical reject devices from the same inspection lot may be used for all subgroups.

2/ Unless otherwise specified, at the manufacturer's option, test samples for bond strength may be selected randomly immediately following internal visual (method 5004) prior to sealing.

3/ All devices must have been through the temperature/time exposure in burn-in. The LTPD applies to the number of leads inspected except in no case shall less than three devices be used to provide the number of leads required.

4/ Except solvents used shall be: (a) Methyl alcohol, per 0-M-232, Grade A, (b) Ethyl alcohol, per 0-E-00760, Type 1, Grade A, (c) Isopropyl alcohol, per TT-I-735, Grade A, and (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) and one (1) part by volume of distilled water.

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TABLE V.- GROUP C TEST

TEST	REQT PARA	MIL-STD-883 METHOD	CONDITION	CLASS B LTPD
Subgroup 1 1/				
Thermal Shock	3.14	1011	Test Condition A as a min.	
Temperature Cycling	3.15	1010	Test Condition A	
Moisture Resistance	3.3.4,3.21	1004		36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	
Visual Examination 2/	3.3			
End point electrical parameters (see 4.6.3(a))				
Subgroup 2 1/				
Mechanical shock	3.16	2002	Test Condition B	
Vibration, variable frequency	3.17	2007	Test Condition A	
Constant Acceleration	3.18	2001	Test Condition A	
Seal	3.13	1014		36
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	
Visual Examination 3/	3.3			
End point electrical parameters (see 4.6.3(a))				
Subgroup 3				
High temperature 4/ storage	3.19	1008	$T_a=85^{\circ}C$ for 24 hours	
End point electrical parameters (see 4.6.3(a))				24
Subgroup 4				
Operating life 4/ (see 4.6.3(b))	3.20	1005	Test Condition B at $71^{\circ}C$	20
End point electrical parameters (see 4.6.3(a))				

1/ Devices used for environmental tests in subgroup 1 may be used for mechanical tests in subgroup 2.

2/ Visual examination shall be in accordance with method 1010 or 1011 at a magnification of 5X to 10X.

3/ Visual examination shall be performed at magnification of 5X to 10X for evidence of defects or damage to case, leads, or seals resulting from testing (not fixturing). Such damage shall constitute a failure.

4/ See 40.4 of appendix B of MIL-M-38510.

4.7.3 Electrical

4.7.3.1 Responsivity (R) - A pulsed LED (λ=820nm ± 5nm) shall be used for the measurement of responsivity. The LED's output shall be coupled into an optical fiber with a numerical aperture less than 0.3. The opposite end of the fiber shall employ a connector (see figure 3) which mates with the module and is connected with the module. The power output of the optical connector shall be calibrated to insure the accuracy of the measurement. A minimum pulse width of 100ns with a t_r and t_f of less than 5ns shall be used. The responsivity shall be defined as the ratio of the output voltage (V_{out}) of the module to the input power (P_{in}) on the detector. The output of the module shall be terminated in a 50 ohms load for this measurement.

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4.7.3.2 Spectral Output Noise Voltage Density (V_n) The output noise voltage shall be measured at center frequencies of 1, 16, 32 and 48MHz with Δf=100KHz or less. (The spectral output noise voltage density shall be defined as the ratio of output noise voltage to the square root of the bandwidth ($\sqrt{BW}$). (See 4.7.3.5). The output of the module will be terminated in a 50 ohm load for this measurement.

4.7.3.3. <u>Output Swing</u> (V_{out}) - The voltage output of the module shall be measured with the optical input port covered. Then, an optical input of power less than 2μW shall be applied to the optical input port and the output voltage measured. The difference in these two output voltage readings shall be defined as the output swing.

4.7.3.4 <u>Module Bandwidth (BW)</u> - A sinusoidal wave modulated LED (Wavelength of 820nm ± 5nm) shall be operated such that the power on the module's detector is less than 1μW. The output of the module will be monitored as the frequency of modulation of the source is varied. The bandwidth will be defined as the difference in lower and upper frequencies corresponding to an output voltage reduction of 3dB from output at 100KHz. The source should supply a constant power output, with a fixed modulation index (see 6.3).

4.7.3.5 <u>Frequency Response Deviation</u> (Δf_r) - With the optical input port uncovered, a P_{opt} of 1 μW shall be applied. R shall then be measured (see 4.7.3.1) at 1 KHz, 1 MHz, 16 MHz, 32 MHz, and 48MHz. The respective Δf_r can then be calculated. (See 6.5).

4.7.3.6 <u>Dynamic Range (DR)</u>- The power of the modulated source, incident on the detector shall be varied by controlling the drive current. That point at which the module output deviates from linearity (with respect to the input power) by more than 25%, will be defined as the upper power limit in linearity. The lower

4.7.3.6 Dynamic Range (DR) - Cont'd

limit shall be taken as the NEP x $\sqrt{BW}$, where BW = 16 MHz (See 6.2). The difference resulting from the upper power limit minus the lower power limit shall be defined as the dynamic range (in dB). This measurement shall be done with a 100ns pulse width and repetition rate of 1 KHz or less.

4.7.3.7 Rise and Fall Time (t_r,t_f) - The rise and fall time shall be measured using a LED(λ=820nm ±5nm) with a rise and fall time of less than 5ns and a minimum pulse width of 100ns. The rise time of the module shall be measured from the 10% to 90% point and fall time from the 90% to 10% point.

51 4.7.3.8 Power Consumption (P_{in}) - The normal operating voltage shall be applied to the module. The temperature of the module shall be varied over the operating range (-50°C to 71°C) and the input currents shall be monitored to insure that the power input does not exceed the value given by $P_{in} = (i_n V_{cc} + i_n V_b) = 50mW$ for the photodetector module and 50 mW for the temperature compensated biasing circuit. This test shall be performed with the optical port covered.

5 PREPARATION FOR DELIVERY

5.1 Preservation, Packaging and Packing - Units shall be prepared for delivery as specified in the contract.

6 NOTES

6.1 Abbreviations, Symbols, and Definitions - The abbreviations, symbols, and definitions are as follows:

6.1 (cont'd)

Δf	Bandwidth used in noise measurements
BW	Bandwidth
DR	Dynamic Range
f	Frequency
Δf_r	Frequency response deviation
i_n	Input current
LED	Light emitting diode
m	Modulation Index
NEP	Noise equivalent power
P_{pk}	Peak optical input power
P_{av}	Average optical input power
P_{in}	Power consumption
P_{opt}	Optical Input Power
R	Responsivity
T_a	Ambient temperature
t_f	Fall time
t_r	Rise time
V_b	Detector bias voltage
V_{cc}	Amplifier operating voltage
V_n	Spectral output noise voltage density
V_{out}	Output Swing
λ	Wavelength
Z_o	Output Impedance

6.2 <u>Noise Equivalent Power</u> - NEP is defined as follows:

$$NEP = V_n/R$$

6.3 Modulation Index (m) - The modulation index is defined for cosinusoidal modulation at a radian frequency ω_m by

$P_{opt} = P_{av}(1+m \cos \omega_m t)$

6.4 Fiber Optic Connector - A fiber optic connector to be used to mate with the photodetector module is shown in Figure 4 The connector is a MIL-C-39012/55 plug modified to incorporate the optical fiber.

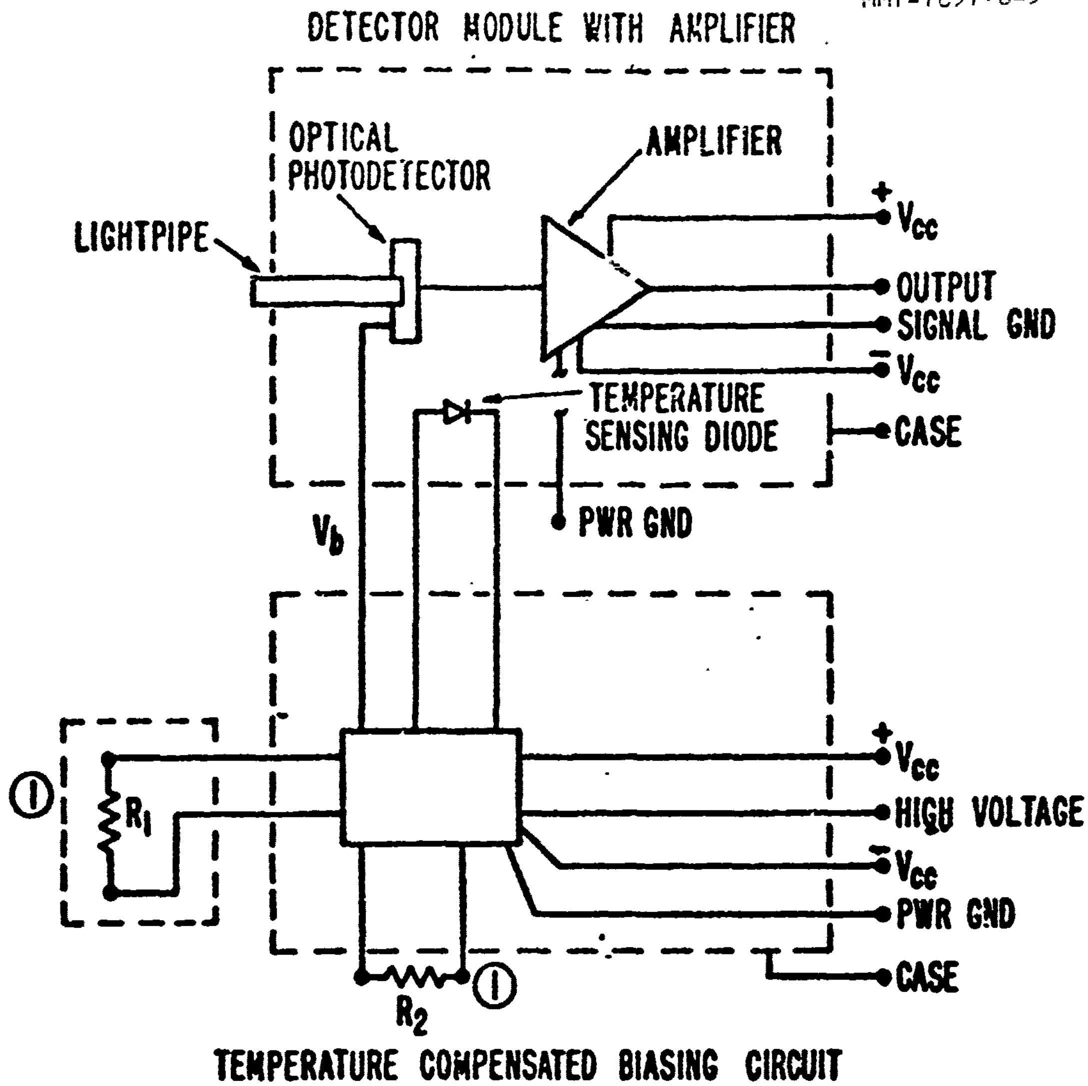
6.5 Calculation of Δf_r

$$f_r = \frac{\{R(1MHz) . f_r(f)\} - R(f)}{R(1MHz) . f_r(f)}$$

where: R(1MHz) = measured responsivity at 1 MHz

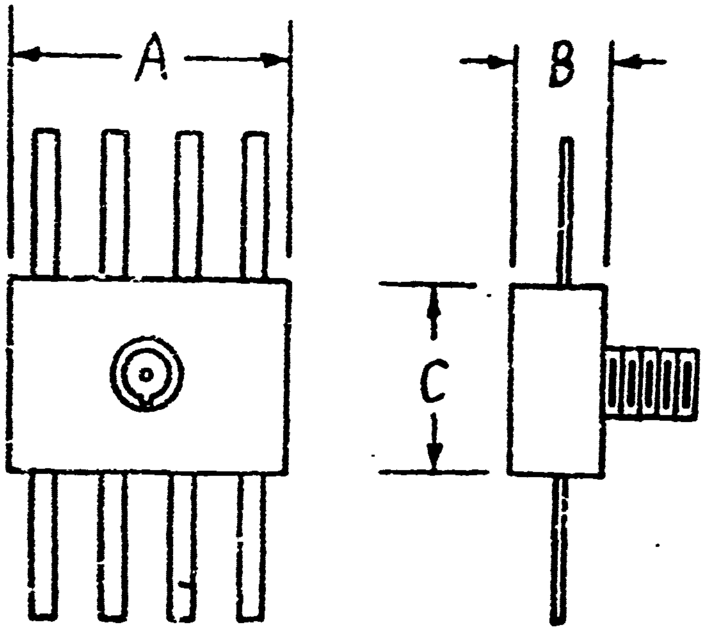
R(f) = measured responsivity at specified frequency f

and, $f_r(f) = \{1 + (\frac{f}{BW})^2\}^{-\frac{1}{2}}$



NOTE : (1) EXTERNAL RESISTORS TO OBTAIN DESIRED RESPONSIVITY.

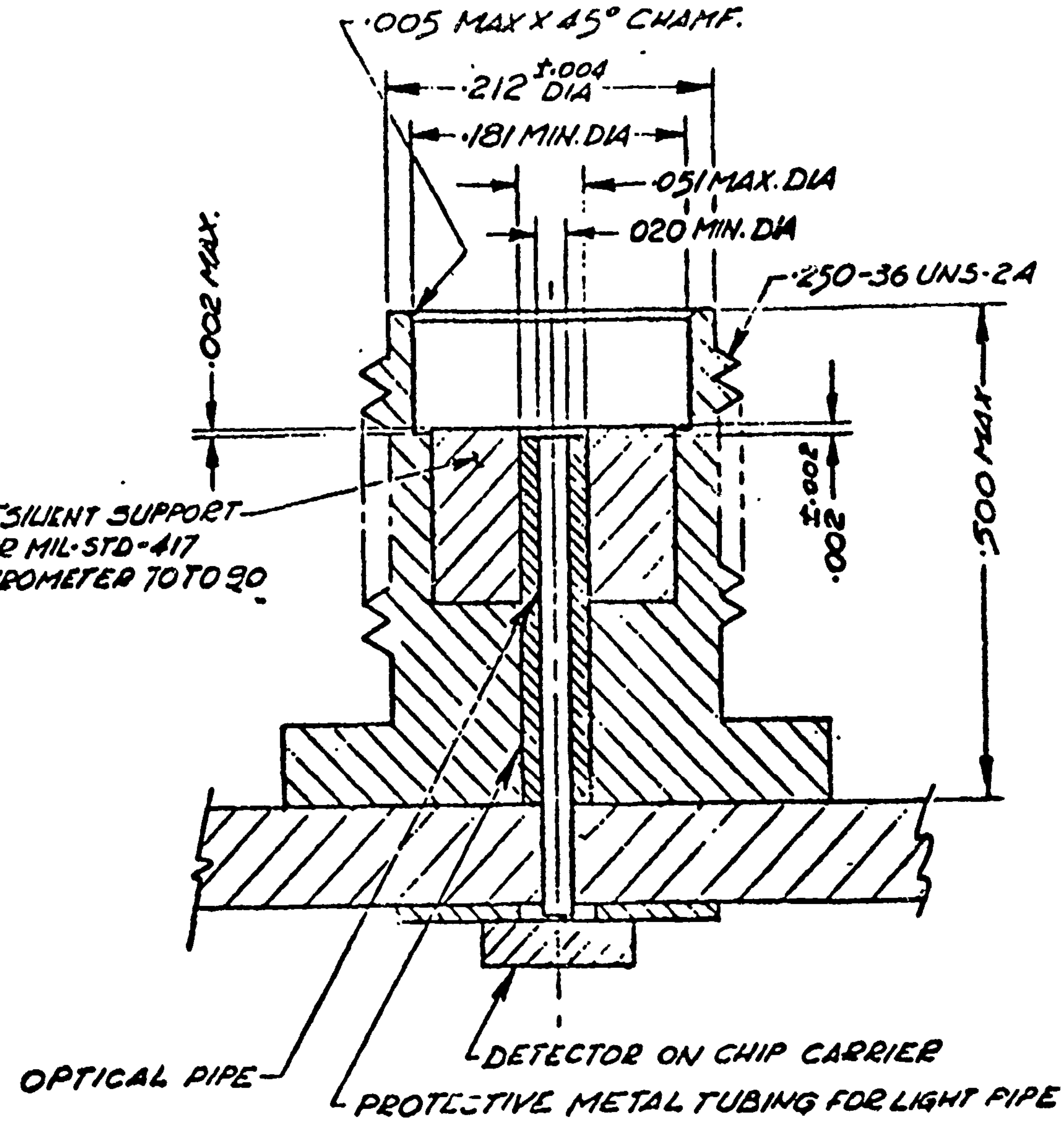
FIGURE I. LOGIC DIAGRAM FOR SAPDM2



Symbol	Inches [1]		Millimeters	
	Min	Max	Min	Max
A		1"		25.4
B		.5"		12.7
C		1"		25.4

[1] Actual dimensions may be much smaller than maximum.

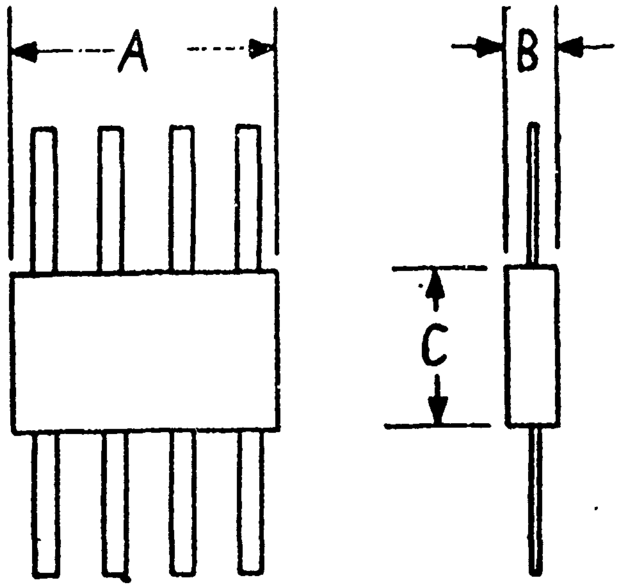
Figure 2. Case Outline



NOTES:

1. Outline of Optical Connector is shown in Figure 5.
2. Provision shall be made to prevent twisting of the optical fiber of the mating connector during mating operation.

Fig 2A. OPTICAL CONNECTOR

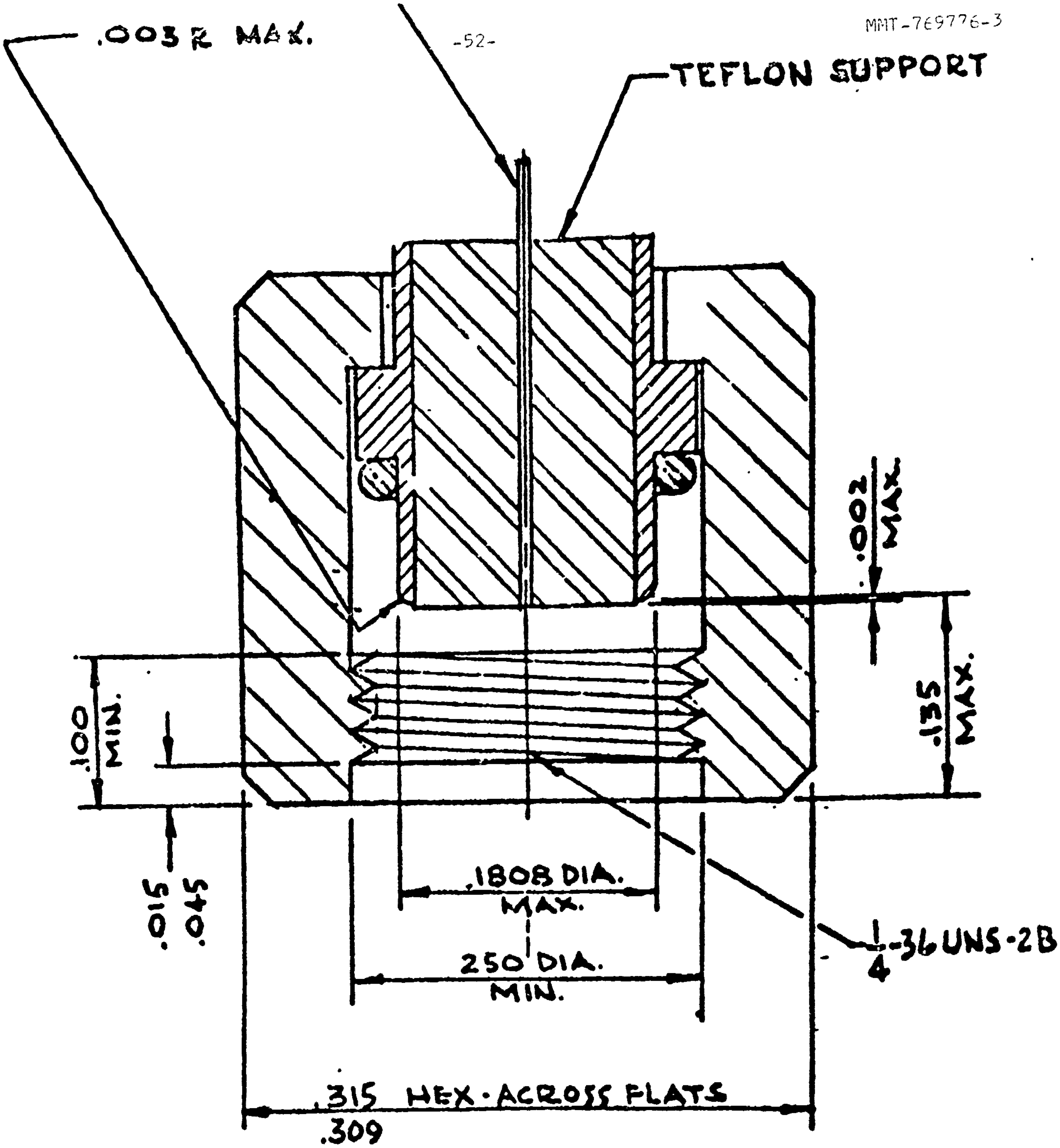


Symbol	Inches[1/] Min	Max	Millimeters Min	Max
A		1"		25.4
B		.5"		12.7
C		1"		25.4

[1/] Actual dimensions may be much smaller than maximum.

Temperature Compensated Bias Circuit

Figure 3



NOTE: PROVISION SHALL BE MADE TO PREVENT TWISTING OF THE OPTICAL FIBER DURING THE MATING OPERATION.

FIG 4. FIBER CONNECTOR

58

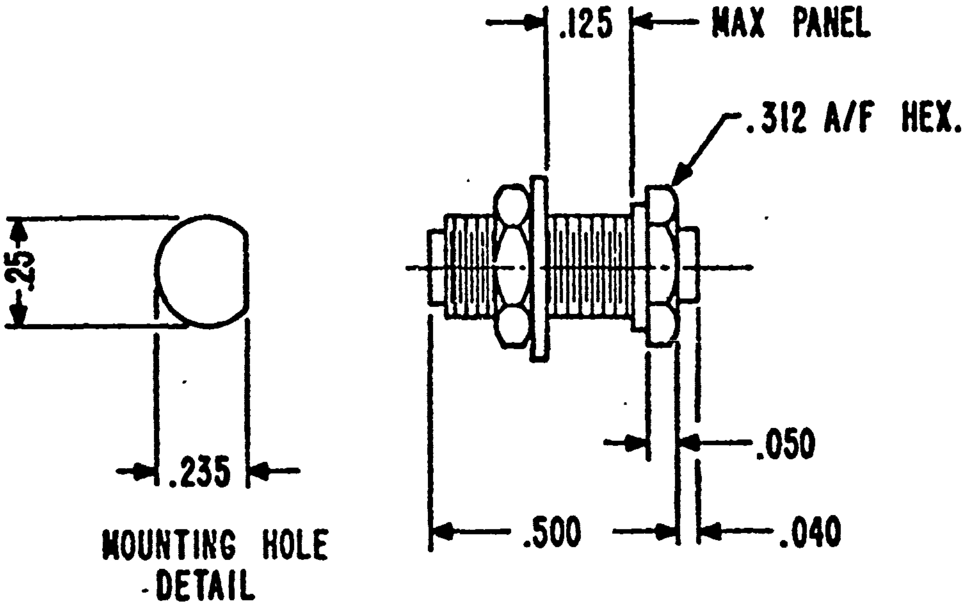


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FIGURE 5. OUTLINE OF PROPOSED OPTICAL CONNECTOR
(MODIFIED VERSION OF STANDARD BULKHEAD
TYPE SMA CONNECTOR)

8.1.3 Electrical Circuit Design

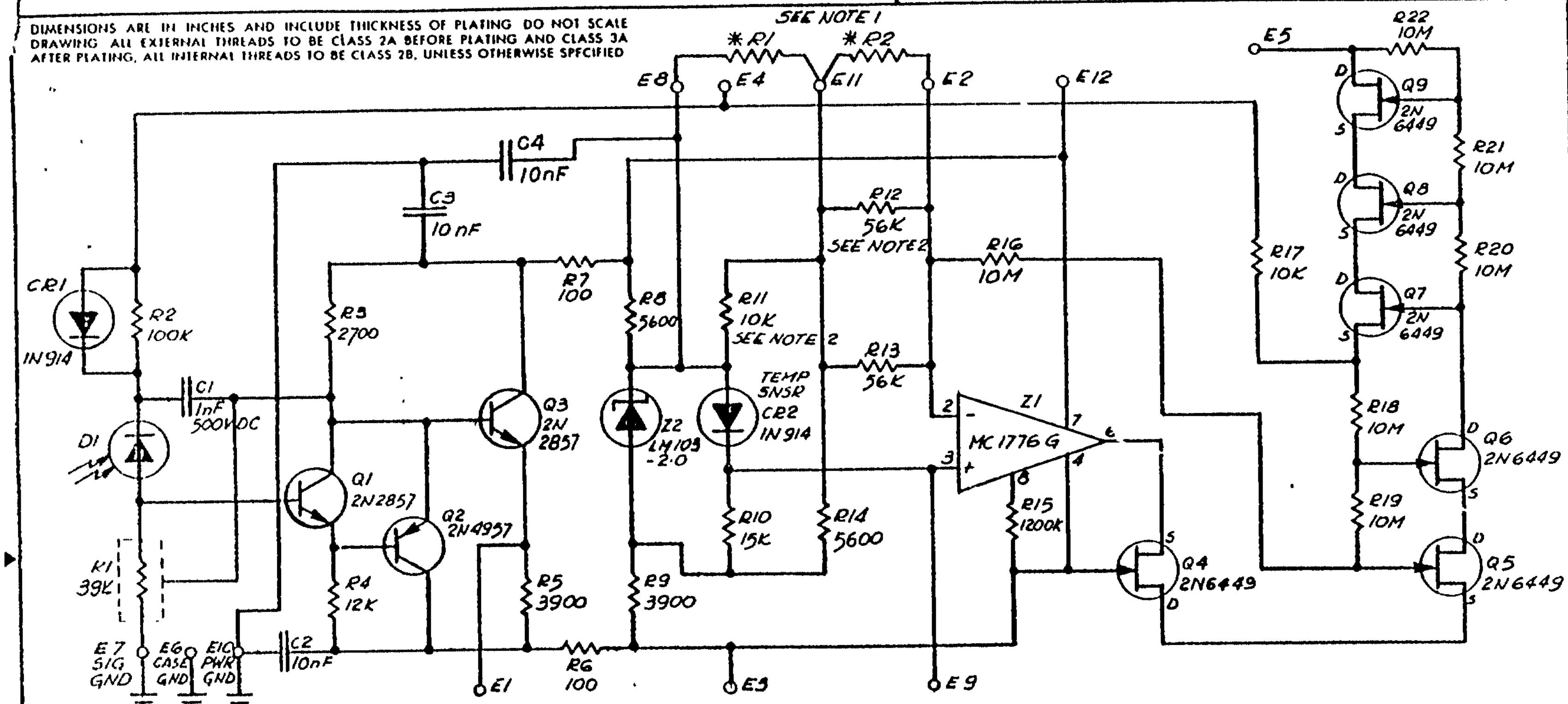
Schematics of the amplifier circuits are shown in the following Figures. It may be seen that the circuit of the SAPDM-2 Module is essentially similar to that of the SAPDM-1 Module, with the addition of the temperature compensation network. In this design, an integrated circuit amplifies the differential input between a set voltage and the voltage developed by a temperature sensitive diode biased at constant current. The I.C. output changes the state of conduction of a high voltage transitor-resistor chain from which the detector bias is derived. Individual control is obtained by adjustment (via two external resistors) of the feedback impedance of the I.C. and the comparator set voltage. This enables the bias set point and its temperature slope to be established for each module.

The principal performance parameters of the module, however, are determined by the front end of the amplifier and can be modified by choice of component values and to some extent by the layout of the circuit on the substrate. We first present the initial analyses undertaken to determine the operating conditions of the avalanche photodiodes and the expected noise performance of the module. Then, a discussion of the choice of actual load resistor values illustrates the manner in which the initial design was modified to provide a unit having improved characteristics.

-55-

61

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING DO NOT SCALE DRAWING ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3A AFTER PLATING, ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED



(1) FOR LIST OF PARTS SEE DWG. NO. 2573605-501

NOTES:

1- SELECT IN TEST RESISTORS *R1 AND *R2 ARE SUPPLIED WITH UNIT FOR EXTERNAL CONNECTION TO PINS E8, E11 AND E2, E11 RESPECTIVELY, * THESE RESISTORS ARE NOT TO BE CONFUSED WITH INTERNAL RESISTORS R1 AND R2.

2- SELECT IN TEST, RESISTOR VALUE MAY BE DIFFERENT THAN NOMINAL VALUE SHOWN.

3- ALL RESISTOR VALUES ARE IN OHMS ±10% UNLESS OTHERWISE SPECIFIED.

4- ALL CAPACITOR VALUES ARE IN NANO-FARADS ±10% AND ARE 50 VDC UNLESS OTHERWISE SPECIFIED.

5- TERMINALS DESIGNATED E1, E2, E3 ..... ETC ARE FOR REF. ONLY.

REVISIONS

AP BY R.R. [illegible] | 0
DATE 77-8-17

DWG TITLE CHANGE WAS TCH/C30818 BIPOLAR PREAMP SCHEMATIC (R,21K) W. RUTA 77-10-17

R.R. [illegible] 77-10-18 | 1

REVISED AS PER ECN 0034 (R1=33K 2ND)

REVISED AS PER ECN 0061 2ND ENG MODEL | 2

REVISED AS PER ECN 0110 (R1 33K CONFIRMATORY SAMPLES) W. RUTA 78-5-30 | 3

R.S. [illegible] 78-5-30 | 4

REVISED AS PER ECN 0209 W. RUTA 78-11-20

R.S. [illegible] 78-11-20 | 5

REVISED AS PER ECN 0348 W. RUTA 79-5-9

R.S. [illegible] 79-5-9 | 6

DWG REVISED AS PER ECN 0443 W. RUTA 79-10-26

R.S. [illegible] 79-10-26 | 7

THIS DRAWING SUBJECT TO REVISION CONTROL

2573605-501
NEXT ASSY 2573586-501

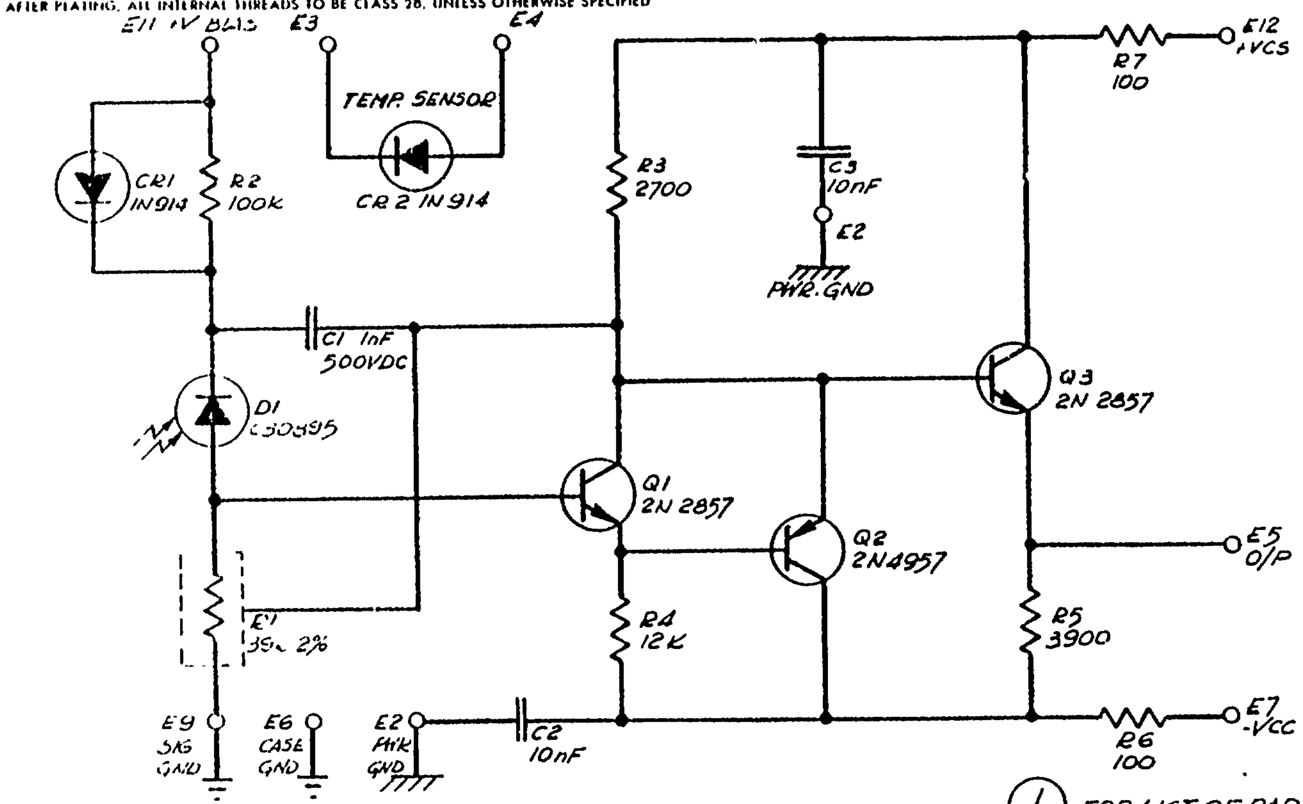
VARIATIONS ON FINISHED DIMENSIONS UNLESS OTHERWISE MARKED		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .005
ABOVE 6 TO 24	± .03	± .010
ABOVE 24	± .06	± .015
ANGULAR DIMENSIONS ± 1/2 DEG		
SEE PURCH SPEC FOR STOCK TOLERANCE		

C30941E PREAMPLIFIER SCHEMATIC

FIRST MADE FOR EO&D/SSD
USED ON MMT 77
DRAWN BY W. Ruta 77-7-29
CHECKED BY [illegible] 77-7-?
DESIGNED BY Mel Te[illegible]
COMMODITY CODE
RCA RCA LIMITED
CODE IDENT NO 95311
SIZE B 1829998
SHEET 1 CONT'D ON SH FINAL

1829998

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED



(1) FOR LIST OF PARTS SEE DWG. NO. 2573580-501

NOTES:

1- ALL RESISTOR VALUES ARE IN OHMS ±5% UNLESS OTHERWISE SPECIFIED.
2- ALL CAPACITOR VALUES ARE IN NANO-FARADS ±10% AND ARE 50VDC UNLESS OTHERWISE SPECIFIED.
3- TERMINALS DESIGNATED E2 E3 ...... ETC ARE FOR REF. ONLY.

REVISIONS	
AP. BY M Teare DATE 77-10-20	0
FOR 2ND ENG. MODEL CHANGE R1 FROM 27K TO 33K, R3 FROM 2700 TO 10K, R4 FROM 12K TO 47K AS PER ECN 0066 W. RUTA 78-5-31	
[signature] 78-5-31	1
FOR CONFIRMATORY SAMPLES, CHANGE R1 FROM 33K TO 39K R3 FROM 10K TO 2700, R4 FROM 47K TO 12K AS PER ECN 0111 W. RUTA 78-5-31	
[signature] 78-5-31	2
REVISED AS PER ECN 0211 W. RUTA 78-11-13	
[signature]	3

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASSY

VARIATIONS ON FINISHED DIMENSIONS UNLESS OTHERWISE MARKED			
BASIC DIMENSIONS	2 PLACE DECIMALS		3 PLACE DECIMALS
UP TO 6	± .02		± .005
ABOVE 6 TO 24	± .03		± .010
ABOVE 24	± .06		± .015
ANGULAR DIMENSIONS ± 1/2 DEG.			
SEE PURCH. SPEC. FOR STOCK TOLERANCE			

C30944E PREAMPLIFIER SCHEMATIC

FIRST MADE FOR EO&D/SSD — USED ON MMT 77

DRAWN BY W. RUTA 77-10-17 — CHECKED BY M Teare

DESIGNED BY M TEARE — COMMODITY CODE

RCA — RCA LIMITED, STE ANNE DE BELLEVUE QUEBEC

CODE IDENT NO 95311 — SIZE B — 2529917

SHEET 1 — CONT'D ON SH FINAL

2529917

8.1.3.1 Noise Voltages

The first engineering samples had an input impedance consisting of a 27KΩ load in parallel with the input impedance of the proposed bipolar-input preamplifier. This is 5.6KΩ multiplied by the transistor gain. Typical gains, measured in this laboratory for the 2N2857 transistor are ∿40 at -50°C, ∿70 at 25°C, and ∿100 at 71°C. Assuming that these gains can vary by a factor of two in either direction, the effective input impedance (R_p) was:

T	MIN	MAX
-50°C	21.7KΩ	25.5KΩ
25°C	23.7	26.1
71°C	24.6	26.4

Assuming the amplifier output impedance is 50Ω, the detector current responsivities required to meet the minimum voltage responsivities of 1.3×10^5 V/W and 6.5×10^5 V/W, across 50Ω load for the SAPDM-1 and 2 respectively were:

T	SAPDM-1		SAPDM-2	
	Min.	Max.	Min.	Max.
-50°C	10.2 A/W	12 A/W	51 A/W	60 A/W
25°C	10	11	50	55
71°C	9.9	10.6	49	53

The estimated worst-case quantum efficiencies (η) and unity-gain responsivities (R_O), including window and light-pipe losses, were:

	1.064μm		.82μm	
T	η	R_O	η	R_O
-50°C	.068	.058 A/W	.80	.529 A/W
25°C	.20	.171	.80	.529
71°C	.30	.256	.80	.529

Thus the required worst-case detector gains were:

T	SAPDM-1	SAPDM-2
-50°C	177	113
25°C	64	104
71°C	41.4	100

The maximum allowable detector noise current i_{nd} in the SCS 467 diode is 1.5×10^{-12} A/Hz$^{\frac{1}{2}}$ at 20 A/W (M=117 max.). This is given, in terms of dark currents, by

$$i_{nd} \quad = \quad 2q\{I_{ds}+I_{db}M^2(2+.02M)\}A^2/Hz$$

Assuming a maximum value of 100nA for I_{ds} at 25°C, we are allowed a maximum value of 1.17×10^{-10} A for I_{db} at 25°C. The activation energies of I_{ds} and I_{db} have been measured to be approximately 0.69 and 0.55 eV respectively. Thus the dark currents at the temperature limits should be:

T	I_{ds}	I_{db}
-50°C	1.2×10^{-11} A	8.8×10^{-14} A
25°C	1×10^{-7}	1.17×10^{-10}
71°C	3.6×10^{-6}	2.0×10^{-9}

The theoretical detector noise currents at the worst-case gains are, therefore,

T	SAPDM-1	SAPDM-2
$-50^{\circ}C$	.07 $pA/Hz^{\frac{1}{2}}$	.04 $pA/Hz^{\frac{1}{2}}$
$25^{\circ}C$	.73	1.3
$71^{\circ}C$	2.1	5.2

The amplifier noise spectral density, referred to the amplifier input, has been measured to be*

$$i_{na} = \{.25+(\frac{f}{1.5x10})^2\}(pA)^2/Hz$$

65

f(MHz)	1	10	20	30	40	50
$i_{na}(pA)/Hz^{\frac{1}{2}}$	.5	.83	1.42	2.06	2.71	3.37

The total noise spectral density, referred to the input, is given by

$$i_{nt}^2 = i_{nd}^2 + \frac{4kT}{R_L} + (\frac{R_L}{R_p} i_{na})^2 A^2/Hz$$

Thus the accumulative noise currents and output voltages, assuming a 3dB roll-off frequency of 30MHz, are as shown in the following table:(Note that the assumed values of output impedance and output load are both 50W).

---

* These measurements were done at room temperature and may be slightly different at the two temperature extremes.

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NOISE CURRENTS AND VOLTAGES

f MHz	SAPDM-1 -50°C i_{nt} $pA/Hz^{1/2}$	SAPDM-1 -50°C v_{nt} $nV/Hz^{1/2}$	SAPDM-1 25°C i_{nc} $pA/Hz^{1/2}$	SAPDM-1 25°C v_{in} $nV/Hz^{1/2}$	SAPDM-1 71°C i_{nt} $pA/Hz^{1/2}$	SAPDM-1 71°C v_{nt} $nV/Hz^{1/2}$	SAPDM-2 -50°C i_{nt} $pA/Hz^{1/2}$	SAPDM-2 -50°C v_{nt} $nV/Hz^{1/2}$	SAPDM-2 25°C i_{nt} $pA/Hz^{1/2}$	SAPDM-2 25°C v_{nt} $nV/Hz^{1/2}$	SAPDM-2 71°C i_{nt} $pA/Hz^{1/2}$	SAPDM-2 71°C v_{nt} $nV/Hz^{1/2}$
1	.94	10.0	1.21	14.3	2.32	28.5	.91	9.9	1.62	19.2	5.3	65.2
10	1.24	12.8	1.42	16.0	2.43	28.4	1.23	12.7	1.78	20.0	5.34	62.4
20	1.90	17.1	1.94	19.1	2.74	28.0	1.89	17.0	2.22	21.8	5.49	56.0
30	2.67	20.5	2.73	22.9	3.19	27.5	2.65	20.3	2.79	23.4	5.73	49.8
40	3.47	22.6	3.26	23.2	3.73	27.5	3.44	22.4	3.44	24.5	6.05	44.6
50	4.28	23.9	3.98	24.3	4.33	27.4	4.25	23.8	4.13	25.2	6.43	40.7

8.1.3.2 Avalanche Photodiode Analysis

The parameters which determine the range of operating voltages of avalanche diodes are as follows:

W = Depletion region width

V_a = Voltage across avalanche region $\sim$125V if diodes are processed similar to SCS467 diodes.

V_d = Voltage required to deplete π region = $qN_a w^2 x 2\varepsilon$

V_d' = Voltage required across drift region to give a charge collection time at $-50^{\circ}C$, adequate to have negligible fall-off in response at 50MHz.

V_{min}= Minimum operating voltage at $-50^{\circ}C$ = $V_a + V_d$ or $V_a + V_d'$, whichever is greater.

ΔV_t = Change in operating voltage over the desired temperature range to maintain constant responsivity. $\Delta V_t \sim 160wV/^{\circ}C$, or $\Delta V_t \sim 19360w$ Volts for the desired $121^{\circ}C$ range ($-50^{\circ}C$ to $+71^{\circ}C$) for the SAPDM-1. For the SAPDM-2, $\Delta V_t \sim 200wV/^{\circ}C$, or ΔV_t = 24,200w Volts for desired range.

ΔV = The voltage window, or the allowed range of room temperature operating voltages. It has been found in practice that from 50 to 60% of usable diodes have operating voltages in a window approximately 12,000w volts wide. A narrower window reduces the yield and thereby increases the price; conversely, a wider window reduces the price.

V_{max}= Maximum operating voltage = $V_{min} + \Delta V_t + \Delta V$

Typical values are shown below for various values of w, using 2ns as a maximum allowable hole transit time, and assuming a 2KΩ π region.

w μm	V_a	V_d	V_d'	V_{min}	ΔV_t (1)	ΔV_t (2)	ΔV	V_{max} (1)	V_{max} (2)
30	125	4.5	6	131	58	73	36	225	240
40	125	8	10	135	71	97	48	260	280
50	125	12.5	16	141	91	121	60	292	322
70	125	24.5	30	155	135	169	84	374	408
100	125	50	58	182	144	247	120	496	544
120	125	72	80	205	232	290	144	581	639

(1) Refers to SAPDM-1 (2) To SAPDM-2

From this data, we make the following observations:

(1) For the SAPDM-1, the nominal thickness of the SCS467(120μm) and the voltage limit of 550V requires that the voltage window, ΔV , be reduced to 113V.

(2) For the SAPDM-2, the maximum voltage available from the TCU is about 500V. This essentially precludes the use of the SCS467 chip without some thinning. Thinning down to the 55μm range, adequate for good quantum efficiency at 0.82μm, allows the voltage to be reduced from 550 to 350.

8.1.3.3 Choice of Passive Resistor Values

The measurements made on the first engineering samples (Part II of this section) reflect agreement with the noise analysis previously described. However, there are some departures from estimated numerical values. Firstly, the module output impedance is closer to 25Ω than 50Ω and secondly, the actual values of photodiode noise were generally lower than predicted, so that the module noise at higher frequencies was dominated by the amplifier noise current. It was also observed that bandwidths were well in excess of the expected values due to better capacitance neutralization.

8.1.3.3 <u>Choice of Passive Resistor Values</u> (cont'd)

The specification had been drawn with a view to ensuring a 6db roll off spectrum over several octaves. However, RCA amplifier design implies a slope approaching 12db owing to the double pole of the amplifier cuicuit. Without equalization circuitry, the best that could be done was to meet the letter of the specification, without fulfilling its intent. For the second engineering samples, the load resistor value was increased to 33KΩ from 27KΩ and the values of the transistor bias resistors R_3 and R_4 increased to 10KΩ and 47KΩ from 2.7KΩ and 12KΩ respectively.

The increase in value of R_3 and R_4 resulted in lower amplifier noise current but introduced unacceptable peaking in the
69 noise spectrum, because of the effect on the capacitance neutralizing feedback. The original values of R_3 and R_4 were reinstated subsequent to the second engineering sample fabrication. Prior to the specification review meeting, a summary was prepared showing the alternatives to be expected from the different values of load resistor. Essentially, higher values of R_L decrease the bandwidth but provide higher sensitivity because the minimum detectable power can be expressed as:

$$P = \frac{\{4kT\,R_L + i_{na}{}^2 R_L{}^2\}^{\frac{1}{2}}\,B^{\frac{1}{2}}}{RR_L}$$

where B is the noise bandwidth and R the photodiode current responsivity in amps per watt. However, the upper limit of detection is severely affected. Because the output swing V_S of the amplifier is fixed the maximum linear detectable power is given by

$$P = \frac{V_S}{RR_L}$$

8.1.3.3 <u>Choice of Passive Resistor Values</u> (cont'd)

so the dynamic range is reduced. In most cases, however, the lower limit of detection is the more important. As will be seen later, this was one of the topics resolved at the specification review meeting.

8.1.4 <u>Mechanical Structure of the package</u>

Detailed drawings illustrating the assembly of the modules may be found on the following pages. Section 8.2 contains a complete description of the processes and equipment used in the fabrication of the assembly. This final design evolved over the course of the engineering phase of the program and the historical development of the packaging methods, in response to problems encountered, is described here.

8.1.4.1 <u>Use of epoxies in the assembly of the modules</u>

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Under this general heading may be discussed the different uses and particular difficulties associated with use of epoxy adhesives in the construction of the module. At the start of the contract, permission was granted to use H20E conductive silver filled epoxy for attachment of components within the package.

It soon became apparent that there existed requirements for the use of an insulating epoxy as well. These were:

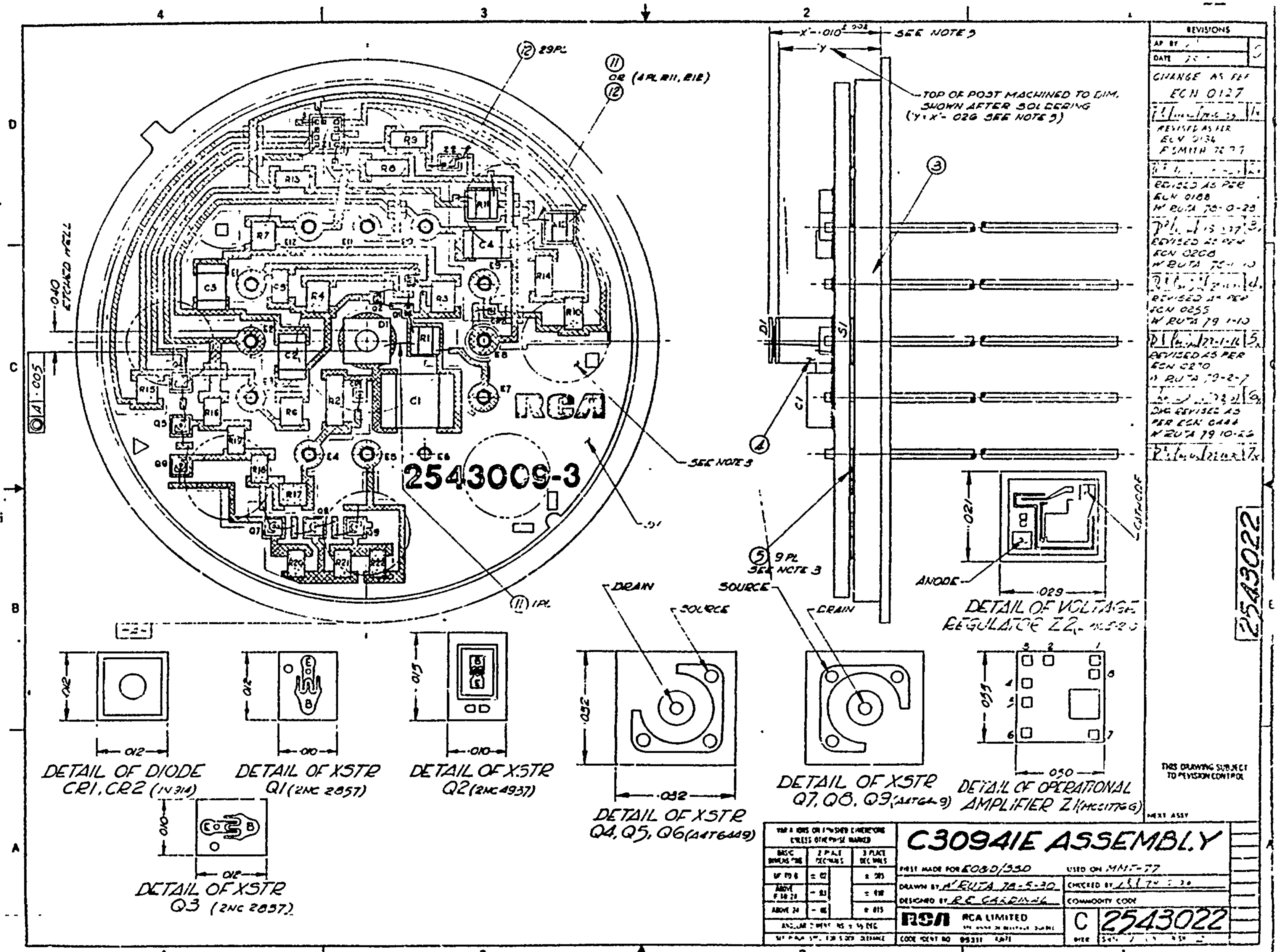
(i) <u>Attachment of the ceramic substrate to the header</u>

Soldering operations present problems of long term reliability when the soldered joint is not readily accessible to flux cleaning solutions.

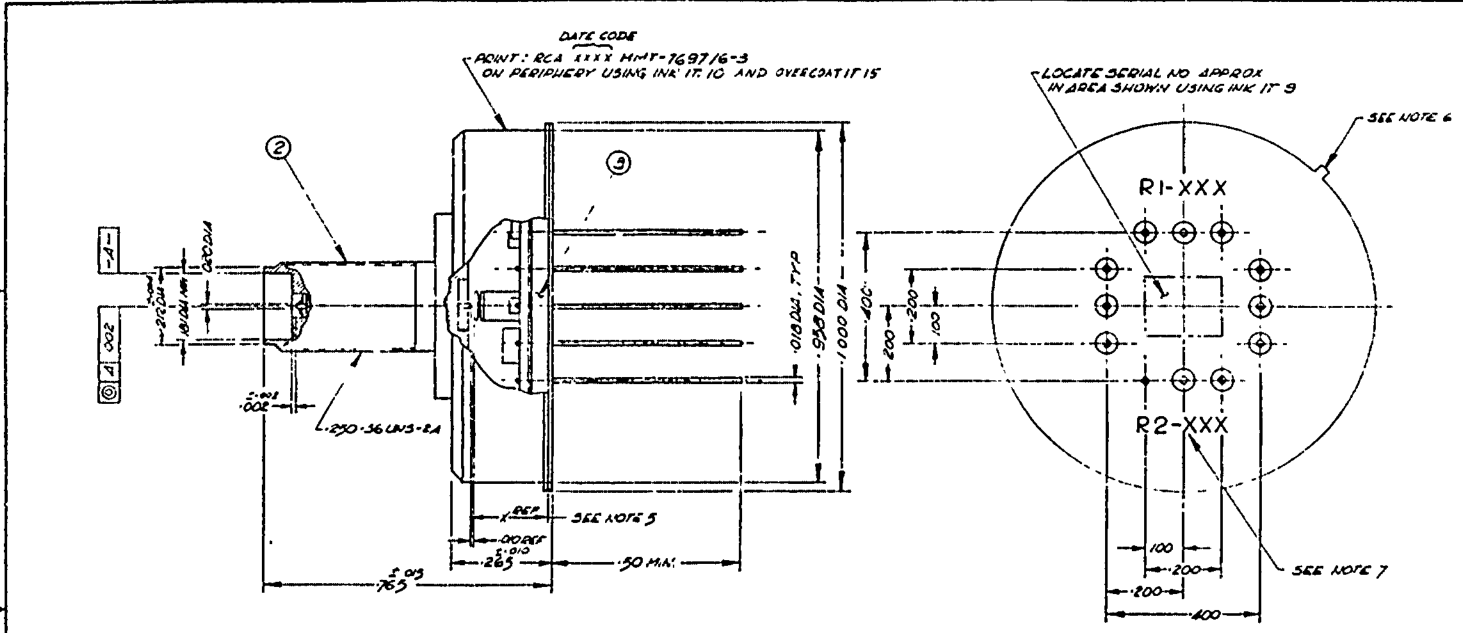
First, approval was obtained for the use of H70E epoxy, on the basis that it is identical to H20E with the substitution of an inert alumina filler for the silver.

Initial units were fabricated using a Kovar or molybdenum spacer between the ceramic and the header, each interface being bonded using H70E epoxy. The adhesion to the gold plating of the header turned out to be insufficient to withstand the constant acceleration experienced during centrifuge tests. Other epoxies, primarily 3M-281, were evaluated for use.

71


C3094IE ASSEMBLY
2543022
2543009-3
RCA
TOP OF POST MACHINED TO DIM. SHOWN AFTER SOLDERING ('Y'+'X'-.026 SEE NOTE 9)
SEE NOTE 9
SEE NOTE 3
.040 ETCHED WELL
DETAIL OF DIODE CR1, CR2 (1N914)
DETAIL OF XSTR Q1 (2NC 2857)
DETAIL OF XSTR Q2 (2NC 4957)
DETAIL OF XSTR Q3 (2NC 2857)
DETAIL OF XSTR Q4, Q5, Q6
DETAIL OF XSTR Q7, Q8, Q9
DETAIL OF OPERATIONAL AMPLIFIER Z1
DETAIL OF VOLTAGE REGULATOR Z2
DRAIN
SOURCE
ANODE
CATHODE
REVISIONS
CHANGE AS PER ECN 0127
THIS DRAWING SUBJECT TO REVISION CONTROL
RCA LIMITED
USED ON MMT-77
COMMODITY CODE
NEXT ASSY

-65-



NOTES

1- COMPONENTS. C1, C2 C3, C4, POST IT 4 AND PINS OF HEADER IT 3 SOLDERED TO SUBSTRATE S [illegible] IT [illegible]

2- [illegible] EPOXIED TO SUBSTRATE S1 USING IT 7

3- MOLY TABS IT 5, SPOT WELDED TO BASE IT. 3 IN 9 LOCATIONS. SUBSTRATE S1 SOLDERED TO BASE IN AREAS SHOWN BY DOTTED LINES, USING SOLDER IT 6.

4- COMPONENTS R11, R12, Z1 AND Z2 EPOXIED TO SUBSTRATE S1 USING IT. 8 (R11, R12 ARE OPTIONAL S/T RESISTORS)

5- DIMENSION 'X' DETERMINED FROM THE LOT OF OPTICAL CONNECTORS TO BE USED.

6- [illegible] IT 2 AND CENTER LINE OF [illegible] OF BASE IT 3 [illegible]

7- PRINT VALUES OF EXTERNAL RESISTORS ✱ R1 AND ✱ R2 AS SHOWN, DO NOT USE DECIMAL POINT USE K (KILOHM) SYMBOL IN PLACE OF DECIMAL POINT USING INK IT. 10 AND OVERCOAT USING IT 15 ✱ THESE RESISTORS ARE NOT TO BE CONFUSED WITH INTERNAL RESISTORS R1 AND R2.

① FOR LIST OF PARTS SEE DWG NO 2572605-501

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED

C30941E ASSEMBLY

RCA LIMITED

C 2543022

2543022

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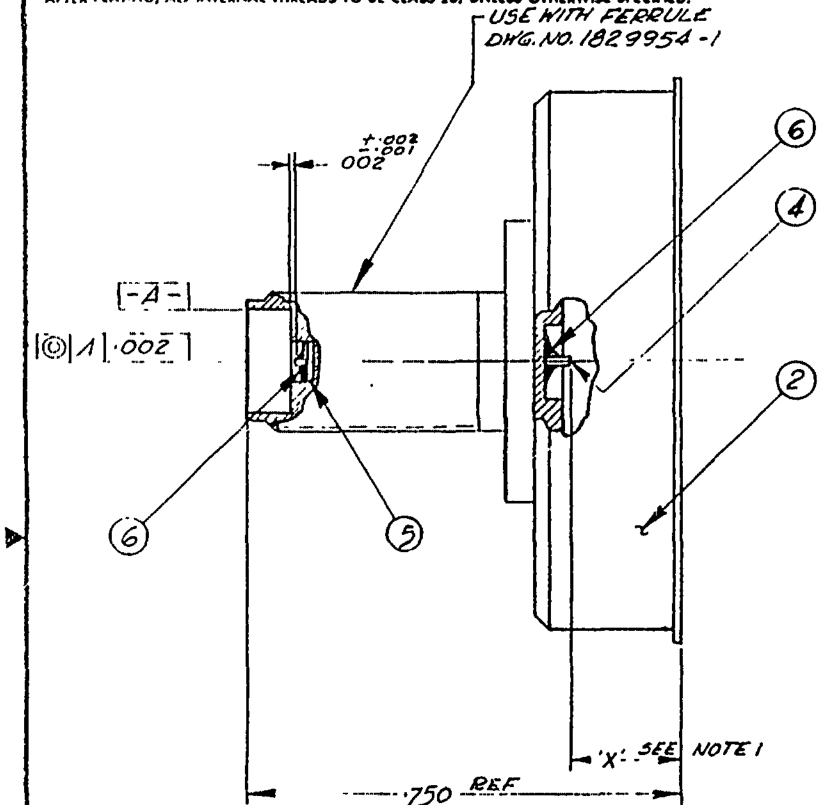
DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3A AFTER PLATING; ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.



(1) FOR LIST OF PARTS SEE DWG NO. 2573604-501 (.010 DIA L.P.)

(2) FOR LIST OF PARTS SEE DWG NO. 2573604-502 (.020 DIA L.P.)

NOTES:

1- VALUE OF 'X' TO BE MEASURED AFTER ASSY, ALLOWABLE RANGE IS $^{+.005}_{-.000}$ THE LENGTH 'X' IS TO BE USED TO DETERMINE THE FINAL HEIGHT OF THE POST IN THE DETECTOR MODEL SUB-ASSY, NOMINAL VALUE OF 'X' IS .181 ±.015

SCALE 5/1

REVISIONS

AP. BY R.C.
DATE

REVISED AS PER ECN
REVISED AS PER ECN
REVISED AS PER ECN

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASSY

WORKMANSHIP TO BE IN ACCORDANCE WITH RCA LIMITED WORKMANSHIP STANDARDS

VARIATIONS ON FINISHED DIMENSIONS UNLESS OTHERWISE MARKED			
BASIC DIMENSIONS	2 PLACE DECIMALS		3 PLACE DECIMALS
UP TO 6	± .02		± .005
ABOVE 6 TO 24	± .03		± .010
ABOVE 24	± .06		± .015
ANGULAR DIMENSIONS ± ½ DEG.			
SEE PURCH. SPEC. FOR STOCK TOLERANCE			

OPTICAL CONNECTOR ASSY 1" DIA

FIRST MADE FOR EO&D/SSD
USED ON
DRAWN BY W. RUTA 79-5-29
CHECKED BY
DESIGNED BY R.E. CARDINAL
COMMODITY CODE

RCA LIMITED

CODE IDENT NO. 95311

SIZE B 2580003

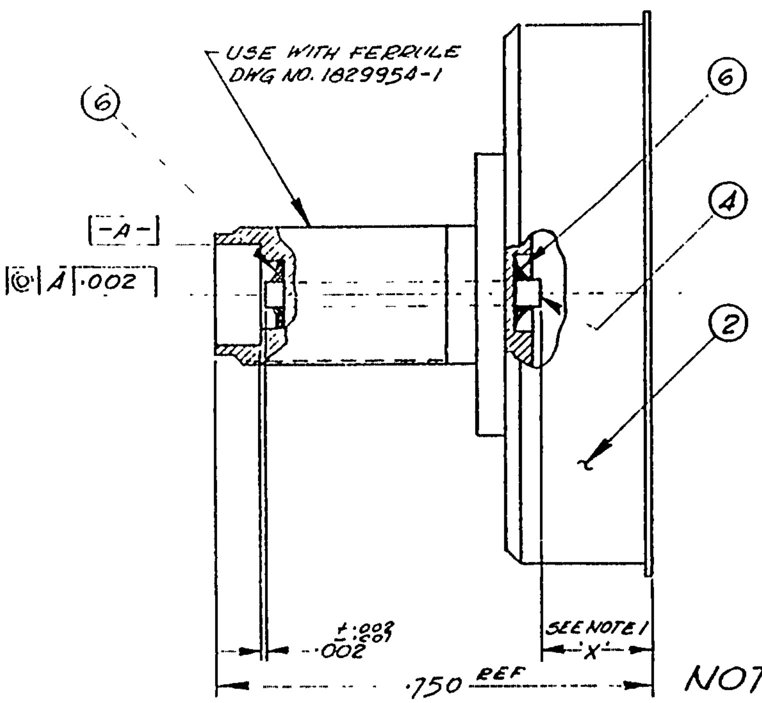
SHEET 1 CONT'D ON SH 2

2580003

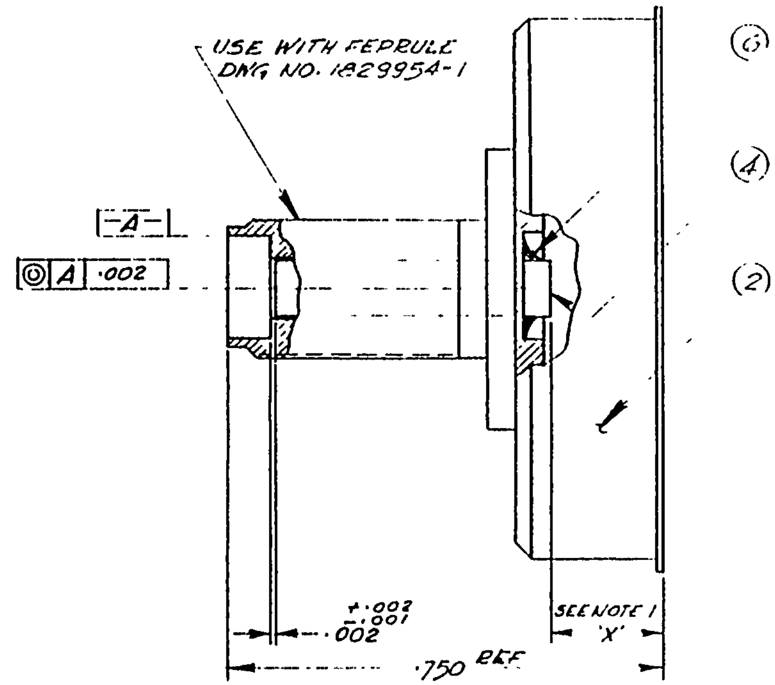
RCA 406-2 REV 8 (RCA 113)

74

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3A AFTER PLATING; ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.



3 FOR LIST OF PARTS SEE DWG NO. 2573604-503 (.050 DIA L.P.)



4 FOR LIST OF PARTS SEE DWG NO 2573604-504 (.100 DIA L.P.)

NOTE:

1- VALUE OF 'X' TO BE MEASURED AFTER ASSY, ALLOWABLE RANGE IS $^{+.005}_{-.000}$ THE LENGTH 'X' IS TO BE USED TO DETERMINE THE FINAL HEIGHT OF THE POST IN THE DETECTOR MODEL SUB-ASSY, NOMINAL VALUE OF 'X' IS .181 ± .015

REVISIONS

AP. BY
DATE

NEXT ASSY

WORKMANSHIP TO BE IN ACCORDANCE WITH RCA LIMITED WORKMANSHIP STANDARDS

VARIATIONS ON FINISHED DIMENSIONS UNLESS OTHERWISE MARKED		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .005
ABOVE 6 TO 24	± .03	± .010
ABOVE 24	± .06	± .015
ANGULAR DIMENSIONS ± ½ DEG.		
SEE PURCH. SPEC. FOR STOCK TOLERANCE		

OPTICAL CONNECTOR ASSY 1" DIA

FIRST MADE FOR EO&D/SSD USED ON

DRAWN BY W. Ruta 79-6-8 CHECKED BY

DESIGNED BY E.E. Cardinal COMMODITY CODE

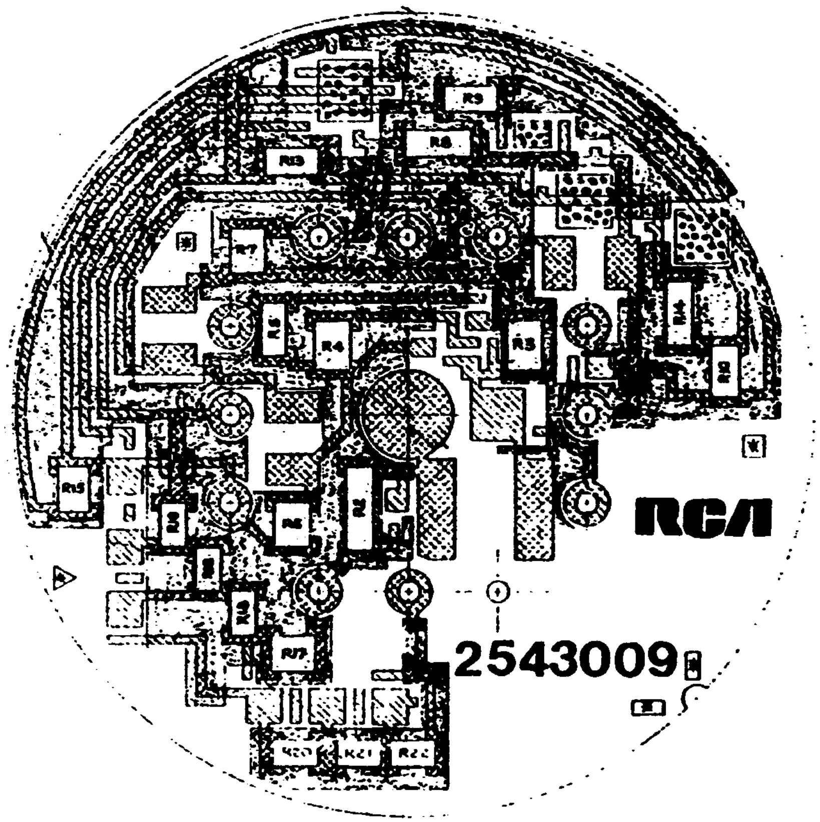
RCA RCA LIMITED

CODE IDENT NO. 95311 SIZE B 2580003 SHEET CONT'D ON SH

2580003

RCA 408-1 REV 0 (RCA 413)

2543009



RESISTOR TABLE

RESISTOR	TRIMMED VALUE	TOLERANCE	MINIMUM [illegible]	MAXIMUM [illegible]	INK BLEND	L × W	L/W	FIRED VALUE	MAX [illegible]
R2	100K	±5%	95K	105K	30K	.075×.030	2.5	75K	75
R3	2.7K	±5%	2.565K	[illegible]	22K	.035×.040	.87	[illegible]	[illegible]
R4	12K	±5%	11.4K	12.6K	10K	.035×.040	.87	9.75K	72
R5	3.9K	±5%	3705	4095	2.2K	.040×.030	1.33	2.92K	75
R6	100	±5%	95	105	100	.030×.040	.75	75	75
R7	100	±5%	95	105	100	.030×.040	.75	75	75
R8	5.6K	±5%	5.32K	5.88K	22K	.050×.025	2	44K	72
R9	3.9K	±5%	3705	4095	2.2K	.040×.030	1.33	2.92K	75
R10	15K	±5%	14.25K	15.75K	10K	.040×.025	1.6	[illegible]	75
R11	56K	±5%	53.2K	58.8K	30K	.040×.030	1.33	40K	[illegible]
R14	5.6K	±5%	5.32K	5.88K	2.2K	.055×.030	[illegible]	[illegible]	72
R15	1.2M	±5%	1.14M	1.26M	1M	.030×.035	.86	[illegible]	.72
R16	10M	±5%	9.5M	10.5M	*10M	.030×.030	1	7.5M	.75
R17	10K	±5%	9.5K	10.5K	10K	.030×.040	.75	7.5K	.75
R18	10M	±5%	9.5M	10.5M	*10M	.030×.030	1	7.5M	.75
R19	10M	±5%	9.5M	10.5M	*10M	.030×.030	1	7.5M	.75
R20	10M	±5%	9.5M	10.5M	*10M	.030×.030	1	7.5M	.75
R21	10M	±5%	9.5M	10.5M	*10M	.030×.030	1	7.5M	.75
R22	10M	±5%	9.5M	10.5M	*10M	.030×.030	1	7.5M	.75

NOTE :- ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE STATED
* INK TO BE ADJUSTED AT 7.5 MΩ DURING FIRING BY ADJUSTING OVEN PROFILE

LEGEND :-

- 1ST GLAZE DUPONT 9429
- 2ND GLAZE DUPONT 9137
- RESISTOR INK 30K/□, 10K/□, 2.2K/□, 100/□ ENGELHARD 2000 SERIES
- RESISTOR INK 10M/□, 1M/□ ENGELHARD [illegible] SERIES
- PLATINUM GOLD INK DUPONT 9596
- GOLD INK DUPONT 9791

(1) USED FOR 1ST ENGINEERING MODEL ONLY

SPECIFICATIONS

1) THE SUBSTRATE SHALL BE RCA PART No. 1823385-1 BACK SIDE IDENTIFIED BY CERAMIC PENCIL DOT.
2) WORKMANSHIP TO BE AS PER APPLICABLE SECTIONS OF MIL-STD-883 METHOD 2017.
3) THE CONDUCTOR PATTERN TO HOLE ECCENTRICITY SHALL NOT EXCEED .005 I.C., .010 LINE AROUND HOLE SHALL NOT BE NARROWER THAN .005.
4) THE CONDUCTOR PATTERN SHALL NOT COME CLOSER THAN .005 TO THE EDGE OF THE HOLE OF UNUSED PINS
5) MINIMUM CONDUCTOR WIDTH SHALL BE .005.
6) MINIMUM CONDUCTOR SPACING SHALL BE .005.
7) THESE ARE FIVE ALIGNEMENT GUIDES (*) PROVIDED ON ALL 10 MASTERS. ANY OF THESE MAY BE PLANKED OF 1/OR USED SEQUENTIALLY BY SUPPLIER

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED.

SCALE 10:1

C3094IE TCH/PREAMP SUBSTRATE.

FIRST MADE FOR EO 8D/S3D

DRAWN BY J.R. BEVAN 12.8.72

RCA LIMITED

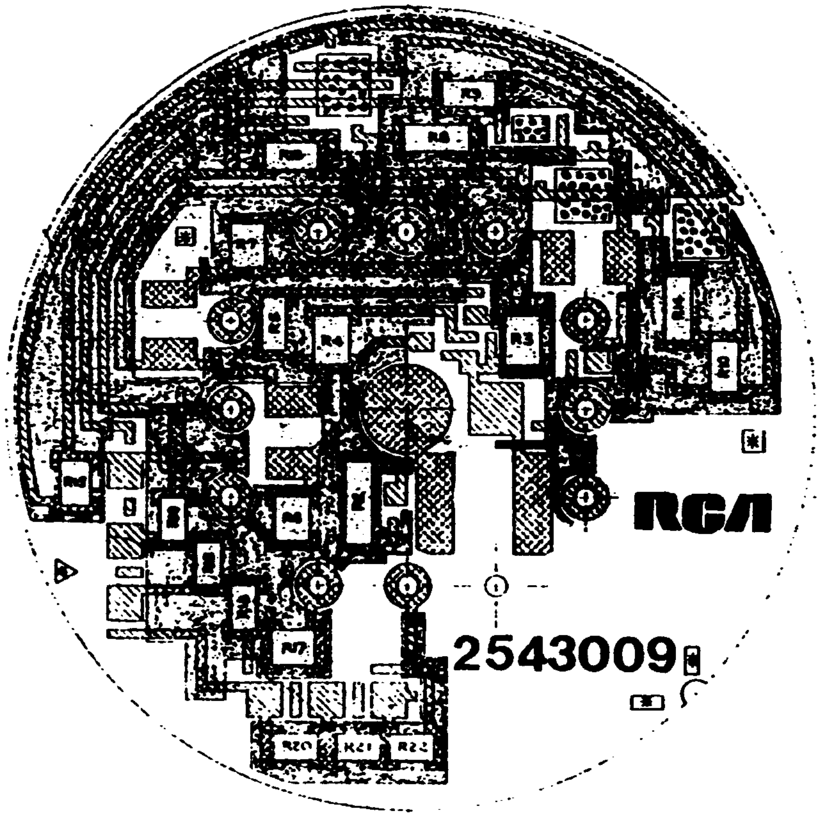
C 2543009

RESISTOR	TRIMMED VALUE	TOLERANCE	MINIMUM	MAXIMUM	INK BLEND	L × W	L/W	FIRED VALUE	FACE VALUE
R2	100K	±5%	95K	105K	30K	·075×·030	2·5	75K	·75
R3	10K	±10%	9K	11K	# #	·055×·045	·87	# #	# #
R4	47K	±10%	42·3K	51·7K	# #	·035×·040	·87	# #	# #
R5	3·9K	±5%	3705	4095	2·2K	·040×·030	1·33	2·92K	·75
R6	100	±5%	95	105	100	·030×·040	·75	75	·75
R7	100	±5%	95	105	100	·030×·040	·75	75	·75
R8	5·6K	±5%	5·32K	5·88K	2·2K	·050×·025	2	4·4K	·72
R9	3·9K	±5%	3705	4095	2·2K	·040×·030	1·33	2·92K	·75
R10	15K	±5%	14·25K	15·75K	10K	·049×·035	1·4	11·42K	·76
R11	56K	±5%	53·2K	58·8K	30K	·040×·030	1·33	40K	·71
R14	5·6K	±5%	5·32K	5·88K	2·2K	·055×·030	1·83	4·03K	·72
R15	1·2M	±5%	1·14M	1·26M	1M	·030×·035	·85	·86M	·72
R16	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R17	10K	±5%	9·5K	10·5K	10K	·030×·040	·75	7·5K	·75
R18	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R19	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R20	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R21	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R22	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75

REVISIONS	
BY	0
DATE 77·3·17	

CONTINUATION OF REVISION SEE SHEET 1

1 2 3 4 5



NOTES: 1- ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE STATED

2-* INK TO BE ADJUSTED AT 7·5 M/□ DURING FIRING BY ADJUSTING OVEN PROFILE

3-# # INK BLEND ADJUSTED BY SUPPLIER

LEGEND :-

- 1st GLAZE DUPONT 9423
- 2ND GLAZE DUPONT 9137
- RESISTOR INK 30K/□, 10K/□, 2·2K/□, 100/□ ENGELHART 3000 SERIES; RESISTOR INK 10M/□, 1M/□ ENGELHART 3100 SERIES
- PLATINUM GOLD INK DUPONT 9596
- GOLD INK DUPONT 9791

(2) USED FOR 2ND ENGINEERING MODEL ONLY

2543009

SPECIFICATIONS

1) THE SUBSTRATE SHALL BE RCA. PART No 182095-1 BACK SIDE IDENTIFIED BY CERAMIC PENCIL DOT.
2) WORKMANSHIP TO BE AS PER APPLICABLE SECTIONS OF MIL-STD-883 METHOD 2017.
3) THE CONDUCTOR PATTERN TO HOLE ECCENTRICITY SHALL NOT EXCEED ·005 I.E., ·010 LINE AROUND HOLE SHALL NOT BE NARROWER THAN ·005.
4) THE CONDUCTOR PATTERN SHALL NOT COME CLOSER THAN ·005 TO THE EDGE OF THE HOLE OF UNUSED PINS.
5) MINIMUM CONDUCTOR WIDTH SHALL BE ·005.
6) MINIMUM CONDUCTOR SPACING SHALL BE ·005.
7) THERE ARE FIVE ALIGNEMENT GUIDES (#) PROVIDED ON ALL MASTERS. ANY OF THESE MAY BE BLANKED OF &/OR USED SEQUENTIALLY BY SUPPLIER.

Best Available Copy

SCALE 10:1

THIS DRAWING SUBJECT TO REVISION CONTROL

C3094IE TCH/PREAMP SUBSTRATE.

FIRST MADE FOR EO & D/SSD — USED ON MT-77

DRAWN BY J. R. SEVAN 18.8.77 — CHECKED BY

DESIGNED BY J. P. GANET 22.8.77

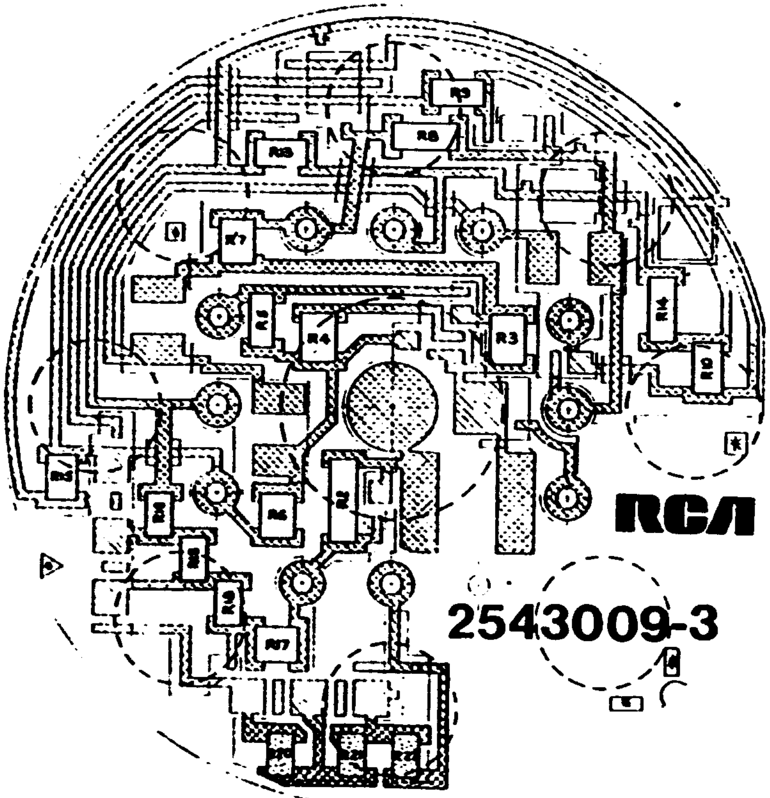
WORKMANSHIP TO BE IN ACCORDANCE WITH RCA LIMITED WORKMANSHIP STANDARDS

RCA — RCA LIMITED

C 2543009

SHEET 2 OF 2

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B UNLESS OTHERWISE SPECIFIED.



Best Available Copy

RESISTOR TABLE

RESISTOR	TRIMMED VALUE	TOLERANCE	MINIMUM	MAXIMUM	INK BLEND	L × W	L/W	FIRED VALUE	FACE VALUE
R2	100K	±5%	95K	105K	30K	·075×·030	2·5	75K	·75
R3	4·7K	±5%	[illegible]	[illegible]	2·2K	·035×·040	·87	[illegible]	·71
R4	12K	±5%	11·4K	12·6K	10K	·035×·040	·87	9·75K	·75
R5	3·9K	±5%	3705	4095	2·2K	·040×·030	1·33	2·92K	·75
R6	100	±5%	95	105	100	·030×·040	·75	75	·75
R7	100	±5%	95	105	100	·030×·040	·75	75	·75
R8	5·6K	±5%	5·32K	5·88K	2·2K	·060×·030	2	4·4K	·72
R9	3·9K	±5%	3705	4095	2·2K	·040×·030	1·33	2·92K	·75
R10	15K	±5%	14·25K	15·75K	10K	·040×·035	1·14	11·42K	·76
R13	56K	±5%	53·2K	58·8K	30K	·040×·030	1·33	40K	·71
R14	5·6K	±5%	5·32K	5·88K	2·2K	·055×·030	1·83	4·0K	·72
R15	1·2M	±5%	1·14M	1·26M	1M	·030×·035	·86	·86M	·72
R16	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R17	10K	±5%	9·5K	10·5K	10K	·030×·040	·75	7·5K	·75
R18	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R19	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R20	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R21	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75
R22	10M	±5%	9·5M	10·5M	*10M	·030×·030	1	7·5M	·75

NOTE :- ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE STATED
* INK TO BE ADJUSTED AT 7·5 M/□ DURING FIRING BY ADJUSTING OVEN PROFILE.

LEGEND :-

- 1ST GLAZE DUPONT 9429
- 2ND GLAZE DUPONT 9137
- RESISTOR INK 30K/□, 10K/□, 2·2K/□, 100/□ ENGELHART 2000 SERIES
- RESISTOR INK 10M/□, 1M/□ ENGELHART [illegible]
- PLATINUM GOLD INK DUPONT 9596
- GOLD INK DUPONT 9791
- BACK METALLIZATION PLAg DUPONT 9770 OR CERMALLOY 4510 M

(3) USED FOR CONFIRMATORY SAMPLES AND PILOT PRODUCTION

SPECIFICATIONS

1) THE SUBSTRATE SHALL BE RCA PART No. 1829985-1 BACK SIDE IDENTIFIED BY CERAMIC PENCIL DOT
2) WORKMANSHIP TO BE AS PER APPLICABLE SECTIONS OF MIL-STD-883 METHOD 2017.
3) THE CONDUCTOR PATTERN TO HOLE ECCENTRICITY SHALL NOT EXCEED ·005 I.D., ·010 LINE AROUND HOLE SHALL NOT BE NARROWER THAN ·005.
4) THE CONDUCTOR PATTERN SHALL NOT COME CLOSER THAN ·005 TO THE EDGE OF THE HOLE OF FUSED PINS
5) MINIMUM CONDUCTOR WIDTH SHALL BE ·005.
6) MINIMUM CONDUCTOR SPACING SHALL BE ·005.
7) THERE ARE FIVE ALIGNEMENT GUIDES (▽) PROVIDED ON ALL [illegible] ANY OF THESE MAY BE PLANNED OF [illegible] SEQUENTIALLY BY SUPPLIER

REVISIONS
77-5
FOR RECORD OF REVISIONS SEE SHEET 1
1 2 3 4 5

2543009

SCALE 10:1

C3094IE TCH/PREAMP SUBSTRATE.

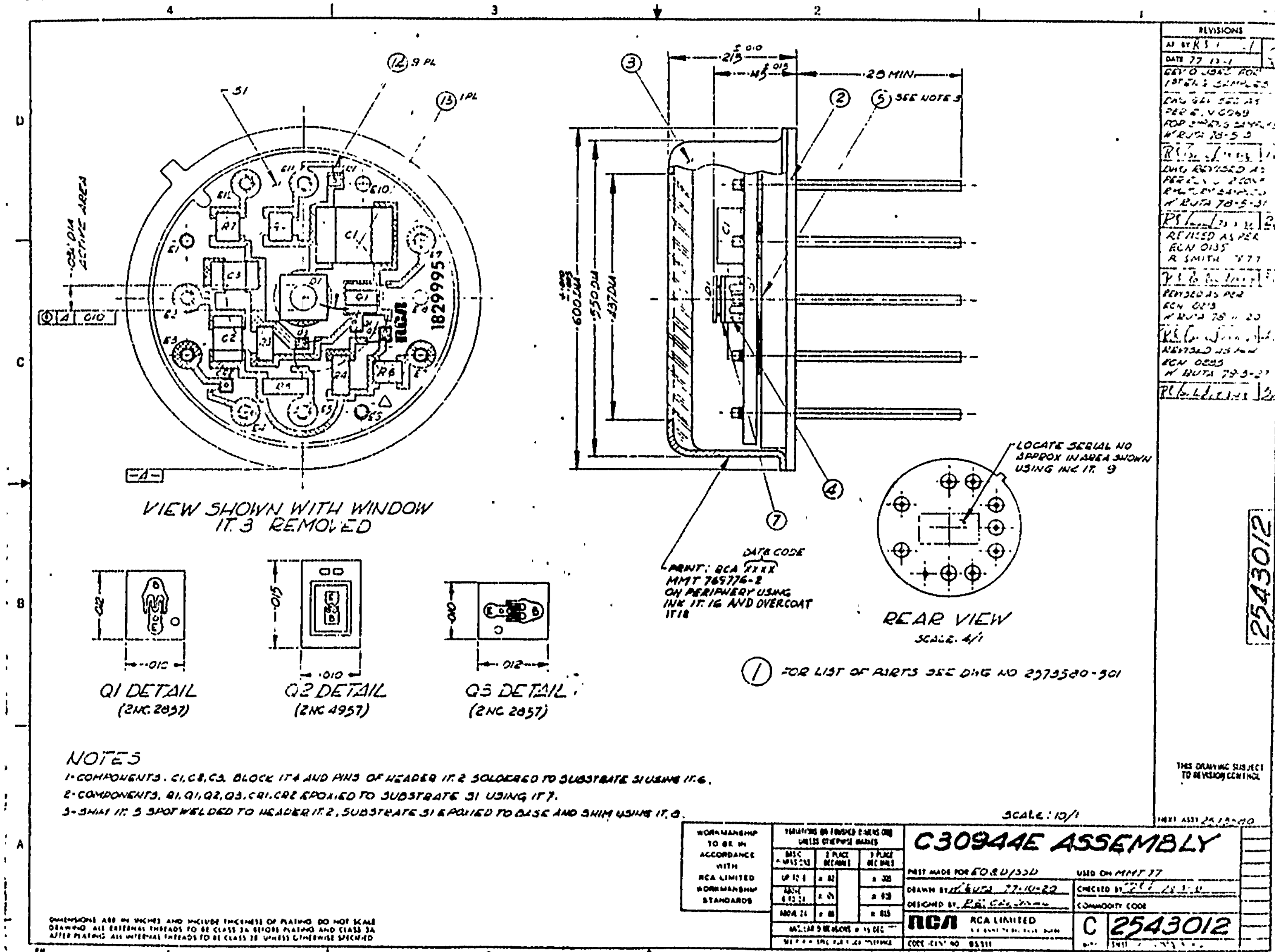
FIRST MADE FOR EC 621/55D

DRAWN BY R. SEWAN 16.8.77

DESIGNED BY J. E. GAMEL 22.8.77

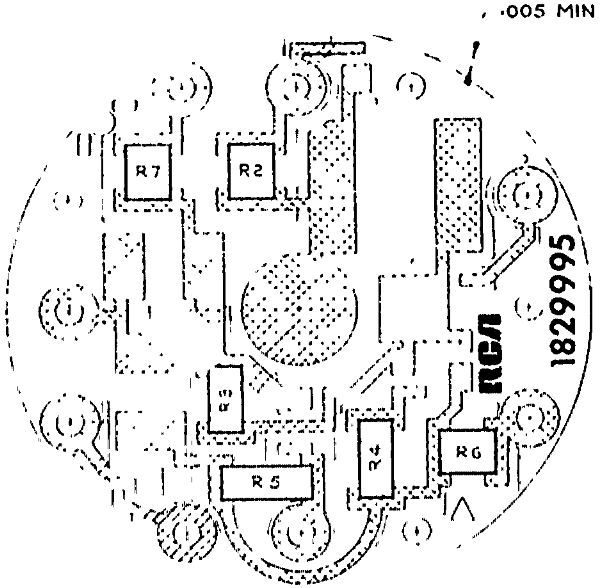
RCA LIMITED

C 2543009



VIEW SHOWN WITH WINDOW IT.3 REMOVED
1829995
RCA
.031 DIA ACTIVE AREA
REAR VIEW
SCALE: 4/1
LOCATE SERIAL NO APPROX IN AREA SHOWN USING INK IT. 9
PRINT: RCA XXXX MMT 765776-2 ON PERIPHERY USING INK IT. 16 AND OVERCOAT IT 18
DATE CODE
.25 MIN
(5) SEE NOTE 3
.600 DIA
.550 DIA
.437 DIA
Q1 DETAIL (2NC 2857)
Q2 DETAIL (2NC 4957)
Q3 DETAIL (2NC 2857)
(1) FOR LIST OF PARTS SEE DWG NO 2973580-501
NOTES
1-COMPONENTS. C1,C2,C3, BLOCK IT.4 AND PINS OF HEADER IT.2 SOLDERED TO SUBSTRATE S1 USING IT.6.
2-COMPONENTS. R1,Q1,Q2,Q3,CR1,CR2 EPOXIED TO SUBSTRATE S1 USING IT.7.
3-SHIM IT. 5 SPOT WELDED TO HEADER IT.2, SUBSTRATE S1 EPOXIED TO BASE AND SHIM USING IT.8.
SCALE: 10/1
C30944E ASSEMBLY
RCA LIMITED
C 2543012
2543012
REVISIONS
THIS DRAWING SUBJECT TO REVISION CONTROL
WORKMANSHIP TO BE IN ACCORDANCE WITH RCA LIMITED WORKMANSHIP STANDARDS

DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING. DO NOT SCALE DRAWING. ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 3A AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED



SPECIFICATIONS

a) THE SUBSTRATE SHALL BE ALSIMAG 614 (.025 THK) FOR 12 PIN TO-8 (APPROX .510 OD).

b) WORKMANSHIP TO BE AS PER APPLICABLE SECTIONS OF MIL-STD-883 METHOD 2017.

c) THE CONDUCTOR PATTERN TO HOLE ECCENTRICITY SHALL NOT EXCEED .005 ie .010 LINE AROUND HOLE SHALL NOT BE NARROWER THAN .005

d) THE CONDUCTOR PATTERN SHALL NOT COME CLOSER THAN .005 TO THE EDGE OF THE HOLE OF UNUSED PINS

e) MINIMUM CONDUCTOR WIDTH SHALL BE .005.

- MINIMUM CONDUCTOR SPACING SHALL BE .005

RESISTOR TABLE

RESISTOR	TRIMMED VALUE	TOLERANCE	MINIMUM	MAXIMUM	INK BLEND	L x W	L/W	FIRED VALUE	FIRED VALUE / TRIMMED VALUE
R2	100K	±5%	95K	105K	100K	.030x.040	.75	75K	.75
R3	2.7K	±5%	2565	2835	1.5K	.040x.030	1.33	1998	.74
R4	12K	±5%	11.4K	12.6K	5.6K	.050x.030	1.66	9360	.78
R5	3.9K	±5%	3705	4095	1.5K	.060x.030	2	3003	.77
R6	100	±5%	95	105	100	.030x.040	.75	75	.75
R7	100	±5%	95	105	100	.030x.040	.75	75	.75

NOTE: ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE SPECIFIED

LEGEND:

- GLAZE INK DUPONT# 9137
- RESISTOR INK 100K/□, 5.6K/□, 100/□ & 1.5K/□ ENGELHART 3000.
- PLATINUM GOLD INK DUPONT 9596
- GOLD INK DUPONT 9791

1

2 SAME AS PART 1 EXCEPT THAT R3 IS 10K±5% AND R4 IS 47K±5% (USED FOR 2ND ENG. MODEL)

REVISIONS

AP BY	R.S. [illegible]
DATE	77-8-[illegible]
0	TYPE NO. FOR GOLD INK DUPONT WAS 8380 W. RUTA 77-8-26
1	R.S. [illegible] 77-8-26 DWG CORRECTED TO CONFORM WITH ARTWORK, PART 1 ADD W. RUTA 77-10-25
2	R.S. [illegible] 77-11-2 REVISED AS PER ECN 0068 W. RUTA 78-5-9
3	R.S. [illegible] 78-5-30 REVISED AS PER ECN 0212 W. RUTA 78-11-13
4	R.S. [illegible] 78.11.2[illegible]

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASSY 2573580-501

VARIATIONS ON FINISHED DIMENSIONS UNLESS OTHERWISE MARKED		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	± .02	± .005
ABOVE 6 TO 24	± .03	± .010
ABOVE 24	± .06	± .015
ANGULAR DIMENSIONS ± ½ DEG		
SEE PURCH SPEC FOR STOCK TOLERANCE		

C30944E PREAMP SUBSTRATE

FIRST MADE FOR EO & D/SSD — USED ON MMT 77

DRAWN BY J R BEVAN — CHECKED BY M. [illegible]

DESIGNED BY J. [illegible] 77-8-[illegible] — COMMODITY CODE

RCA — RCA LIMITED, STE ANNE DE BELLEVUE QUEBEC

SIZE B — 1829995

CODE IDENT NO 95311 — SHEET — CONT'D ON SH —

1829995

8.1.4.1 Use of epoxies in the assembly of the modules (cont'd)

(i) Attachment of the ceramic substrate to the header (cont'd)

The 3M epoxy, while providing good adhesion, proved to be easily attacked by the cleaning solutions used to remove organic residues. As a subsequent approach, nickel plated Kovar tabs were soldered to the header using a tin-silver epoxy, and the substrate epoxied to the tabs using H70E epoxy. This method resulted in very satisfactory adhesion strengths.

Notwithstanding the success of this scheme, it was felt that a more effective means of attachment could be devised, as follows. The substrate was metallized by evaporation in islands on the reverse side. Molybdenum tabs were spot welded to the base and the substrate then soldered onto the tabs. Thus, finally, epoxy was eliminated from the mounting operation.

(ii) Attachment of Electrical Components

Most of the discrete transistor and resistor components are epoxied to the substrate using H20E epoxy. The integrated circuits of the SAPDM-2 are attached using H70E insulating epoxy since they lie over an insulating varnish protecting a lower level of interconnects. No problems were experienced in these operations. The avalanche photodiode - molybdenum tab sub-assembly is also attached to the elevated post using H20E conductive epoxy. This two-step-operation is undertaken to minimize expensive chip mounting failures, which would necessitate extensive reworking or rejection of the entire assembly.

(iii) Mounting of the light pipe in the connector

The cladded light-pipe is inserted in the connector barrel and bonded using H70E epoxy. This is a hermetic seal operation. However, it is not the final seal which is made by subsequent resistance welding of the package, so cleaning and degassing can be accomplished so as to eliminate reliability problems associated with the epoxy. Stringent tests were applied to investigate the ruggedness of the hermetic seal. The results were excellent, as may be seen.

A group of 15 light-pipes epoxied to connectors (H70E) were thermally cycled and tested for hermeticity using a helium leak detector. The test sequence was as follows:

(a)	Hermeticity Test	15/15 good
(b)	Visual Transmission (through light-pipe)	15/15 good
(c)	Thermal cycling $-65^{\circ}C$ to $+75^{\circ}C$ 15 cycles 30 min. at T	15
(d)	Thermal cycling 2 ovens $-65^{\circ}C$ $+150^{\circ}C$ 10 cycles 30 min. at T	15
(e)	Hermeticity	15/15 good
(f)	Thermal Shock $0^{\circ}C$ and $100^{\circ}C$, water 2 baths, 15 cycles	15
(g)	Visual (transmission through light-pipe)	15/15 good
(h)	Hermeticity	15/15 good
(i)	Thermal Shock $22^{\circ}C$ air (room) to $-196^{\circ}C$ (LN_2) 15 cycles 5 min. at T	15
(j)	Visual (transmission through light-pipe)	15/15 good
(k)	Hermeticity	15/15 good

81

8.1.4.2 Layout of the Substrate

During the course of the program, only one change of significance was made to the substrate layout. This change was the re-orientation of the resistors

R20, 21, 22, on the SAPDM-2 network. They were rotated by 90° angle to minimize variations between resistors having nominal value $10M\Omega$.

8.1.4.3 Design & Construction of the Light-Pipe Cover

As stated previously, the decision was made to attempt the engineering phase samples using a single package concept for the SAPDM-2. The inch diameter cover was designed in two parts - a flat Kovar lid with a central hole and a brass barrel connector. The two pieces were soft soldered together and the light-pipe then inserted into the connector. The second engineering models had a locking pin inserted eccentrically in the connector. This pin mated with a corresponding hole in the ferrule of the

8.1.4.3 Design & Construction of the Light-Pipe Cover(cont'd)

fiber termination. This provision was requested by the army to prevent twisting of the ferrule in the connector and the accidental insertion of the wrong king of termination.

After prototype assembly evaluation two problems were observed. First, the large area cover proved to be too flexible, enabling deflections of several mils to occur as a result of the manual operation of attaching the fiber termination. These deflections were felt to be hazardous, as they could exceed the clearance between the end of the light-pipe and the avalanche photodiode chip. It was decided to add a large internal stiffening washer, made of Kovar, and soldered to the inside cover of the lid.

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Problems were also encountered in the mechanical configuration of the locking pin. It was found to be difficult and expensive to fabricate pins of the right size and strength. Extensive modifications to the ferrule and nut of the fiber termination were required because the existing design permitted the nut to engage the thread before the pin was securely located in the ferrule. Some prototype assemblies were made for demonstration but the antitwist protection was finally omitted from the second engineering samples.

A series of problems then arose with the connector cover assembly. To begin with, the connector separated from the cover on one of the second engineering samples while a fiber was being manually attached. As a result, the undelivered second engineering samples were successfully screened for torque strength. However, during shock and vibration testing, all units developed cracks at the solder joint.

8.1.4.3 Design & Construction of the Light-Pipe Cover (cont'd)

It was then clear that the soft soldered joint was inadequate to withstand the stresses to be expected in an operational environment.

A run of prototype assemblies was then instituted over and above the second engineering samples. First, the connector-cover joint was made with silver braze instead of soft solder. This imparted sufficient mechanical strength to the joint. Subsequent attachment of the stiffening washer became a problem because removal of flux residues from the large area turned out to be quite difficult. Lastly, the gold plating operation was complicated by the existence of dissimilar metals in the assembly, and platings suffered from non-uniform thickness, blistering and peeling. This problem is exaggerated when plating is reworked.

It eventually became clear that the only cost effective approach in the long run was to machine the whole connector cover assembly from a single piece of metal. This monolithic approach was tried out in brass and then 303 stainless steel. Although the brass covers do not form a good resistance weld, results obtained on the gold plated stainless steel were uniformly excellent. Subsequent modules on the program were all fabricated by this means.

8.1.5 Specification Review Meeting

A specification review meeting was held at ECOM in New Jersey on June 2nd, 1978, to discuss technical progress and requirements. The purpose of the meeting was to discuss changes to the specification of mutual advantage to both sides, based on experience gathered from investigative work performed during the engineering phase. The principal topics raised by RCA at this meeting were as follows:

(i) The value of the load resistor.

(ii) Δf_r the desirability of the 6db roll off and the required bandwidth to meet the specification.

(iii) Anti-reflection coating of the light-pipe for the fiber optic module.

(iv) The desirability of the locking pin specified.

(v) The design and assembly of the fiber optic connector.

After detailed discussion pertaining to the electrical and mechanical performance of the modules, and the desirability of the various options and trade-offs presented by RCA, a concensus of agreement was reached on some particular amendments to be made to the specifications for the two module types.

(1) The transistor bias resistors would be reduced to their original design values to eliminate undesirable peaking of the frequency response spectrum.

(2) The photodiode load resistor value would be increased to 39KΩ. An improvement in signal to noise ratio is then obtained because the signal voltage is $I_p R_L$ while the resistance noise portion of the total module noise is just $(4kTR_L)^{\frac{1}{2}}$. Such a change is equivalent to an improvement (decrease) in noise equivalent power (N.E.P.).

(3) The equivalent dynamic range resulting from a value of R_L = 39KΩ was acceptable. It was noted that because the upper limit is determined by amplifier saturation and the lower limit by noise voltage the ratio of maximum to minimum measureable radiation power is given by

$$\frac{V_S}{\sqrt{(4KTR_L + V_a^2)B}}$$

where V_a is an equivalent amplifier noise voltage and B is the bandwidth of measurement. So the dynamic range for fixed B is degraded by an increase in R_L.

It is of interest to note, however, that the module is expected to be the bandwidth limiting component in operating system conditions. Thus the "true" dynamic range is actually increased by an increase in R_L because $B \propto R_L^{-1}$.

(4) The net bandwidth obtainable from $R_L = 39K\Omega$ is still in excess of that specified. It was made clear that the design concept of the RCA positive feedback amplifier was not consistent with a 6db roll off slope. The actual frequency response is closer to 12db slope above the 3db point and is quite suitable for ECOM's requirements. Performance improvement obtained by $R_L = 39K\Omega$ outweighs the desirability of the original noise spectrum requirement which would have required a much lower load resistor value to achieve. The specification on Δf_r was agreed to be removed as being unnecessarily cumbersome, and replaced by specified values of the noise voltage at chosen frequencies of measurement.

(5) The frequency response of responsivity was to be measured by plotting of the equivalent illuminated noise voltage spectrum. When the level of illumination is high enough to swamp the frequency dependent noise currents of the amplifier then the spectrum of the noise is the same as the spectrum of the signal (times a normalizing factor). This would apply

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to any fully depleted detector.

(6) The anti-reflective coating on the light-pipe element was not properly a requirement of the specification, and might be omitted at will provided that performance is satisfactorily maintained without it This relieved the problem of a potentially high cost element, which would be difficult to protect from damage.

(7) The locking pin portion of the connector assembly was no longer required. Samples were demonstrated having a pin robust enough to to prevent insertion of an improper fiber termination. However, that made the possibility of using adapters for any other termination type impossible. Additionally, because the pin projects far enough to strike the ferrule before the ferrule is positionally engaged, damage to the ferrule termination was thus possible, if care is not taken during the insertion. It was confirmed that the monolithic shell approach was acceptable, subject to successful operation.

8.1.6 A Revised Specification

It was decided at the meeting that the contractor (RCA) would prepare revised specifications and submit them to U.S. Army authorities for approval. These specifications were to reflect the changes discussed at the meeting and include performance figures based on the component values which were agreed to be used.

These specifications were prepared and submitted in the first half of July, and the final agreed versions appear in the following pages.

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REVISED SPECIFICATIONS

MMT-769776-2
&
MMT-769776-3

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ELECTRONICS COMMAND
TECHNICAL REQUIREMENTS

MMT-769776-2
6 August 1976
Revised 2 June 1978
and 29 Sep 78

SILICON AVALANCHE PHOTODETECTOR MODULE
FOR RANGEFINDER APPLICATION

1. SCOPE

1.1 Scope. This specification covers the detail requirements for a Silicon Avalanche Photodetector Module (SAPDM1) for the detection of 1060 nanometer (nm) radiation for rangefinder applications.

1.2 Device class. Device shall be class B as defined in MIL-M-38510.

1.3 Maximum operating conditions.

V_{cc} = +6V,-6V

V_b = 550 V

P_{in} = 75 mW

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invention for bids or request for proposals, form a part of this specification to the extent specified herein:

SPECIFICATIONS

FEDERAL

O-E-00760	Ethyl Alcohol (Ethanol); Denatured Alcohol; Proprietary Solvents and Special Industrial Solvents.
O-M-232	Methanol (Methyl Alcohol).
TT-I-735	Isopropyl Alcohol
MMM-A-131	Adhesive, Glass to Metal
MMM-A-134	Adhesive, Epoxy Resin, Metal to Metal Structural Bonding.

MILITARY

MIL-C-675	Coating of Glass Optical Elements
MIL-M-38510	Microcircuits, General Specification for.

OTHER

SCS-467	Solid State Avalanche Detector.

STANDARDS

MILITARY

MIL-STD-883 Test Methods and Procedures for Microelectronics

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both title and number or symbol should be stipulated when requesting copies.)

3. REQUIREMENTS

3.1 Description of SAPDM1.- The SAPDM1 is a high speed, high quantum efficiency device. This module is used for rangefinder applications, in particular, for the hand held rangefinder AN/GVS-5. This module is a hermetically sealed unit which operates over the temperature range from -50°C to 71°C. It contains a silicon avalanche photodiode and a high speed, low noise amplifier, which has an extremely fast recovery time from high signal inputs. An avalanche multiplication gain control circuit is not incorporated in this module; however, an input is provided for to directly bias the avalanche diode.

3.2 Performance characteristics.- Performance characteristics shall be as specified in Tables I, III, IV and V.

3.3 Design, construction and physical dimensions.- The design, construction and physical dimensions shall be as specified in MIL-M-38510 and herein. The following exceptions shall apply to paragraph 3.5.1 of MIL-M-38510:

(a) Epo-Tek H20E (Epoxy Technology Inc., Watertown, MA) may be used to mount the chip devices to the substrate of the silicon pin photodetector-preamplifier hybrid circuit.

(b) Adhesives conforming to Federal Specifications MMM-A-131 and MMM-A-134 may be used (where applicable) for package sealing.

(c) A Government approved epoxy may be used for attachment of the substrate to the package.

(d) Epo-tek H70E epoxy may be used for internal attachment of components.

The above exceptions shall apply only if the materials specified are used.

3.3.1 Logic Diagram.- The logic diagram shall be as specified on Figure 1.

3.3.2 Case Outline.- The case outline shall be in accordance with Figure 2.

3.3.3 Lead material and finish.- The lead material shall be Type A or B and lead finish shall be gold plate, per paragraphs 3.5.6.1 and 3.5.6.2, respectively, of MIL-M-38510.

3.3.4 Metals.- External metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion.

3.4 Electrical performance characteristics.- The electrical performance characteristics are as specified in Table I, and apply over the full ambient operating temperature range of -50°C to 71°C unless otherwise specified.

3.5 Rebonding.- Rebonding shall be in accordance with paragraph 3.7.1.2 of MIL-M-38510.

3.6 Marking.- Marking shall be in accordance with MIL-M-38510 except the following information shall be marked on each microcircuit.

(a) Date code
(b) Manufacturer's identification
(c) Part number: MMT-769776-2

3.7 Interchangeability.- Any change which affects functional interchangeability and/or pin to pin replaceability shall require assignment of a new part or type number.

3.8 Window.- The window shall contain no strains or cracks over that portion which is in the optical path (area of input radiation incident on the silicon avalanche photodiode chip). The center portion of the window shall have a 0.150 inch minimum diameter and be free from optical distortion and lens effects. The window may be anti-reflection coated on both surfaces for a λ = 1060 nm.

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3.9 Resistance to solvents.- When the device is subjected to solvents, there shall be no evidence of: (a) mechanical damage, (b) deterioration of the materials or finishes, and (c) illegibility of case marking.

3.10 Bond strength.- The bond shall meet the minimum bond strength requirements listed in Table I of method 2011 of MIL-STD-883.

3.11 Solderability.- All electrical terminals shall be solderable.

3.12 Lead integrity.- With a force of 8 ounces applied to the leads for three 90 $\pm$ 5 degree arcs of the case, there shall be no evidence of breaking.

3.13. Seal.- For fine leak, the maximum allowable leakage rate shall not exceed 5×10^{-7} atm cc/sec. For gross leak, the maximum allowable leakage rate shall not exceed 1×10^{-3} atm cc/sec.

3.14 Thermal shock.- After being subjected to specified temperature conditioning, there shall be no evidence of defects or damage to case, leads, or seals or loss of marking legibility.

Table 1.- Electrical performance characteristics 1/

Characteristic	Symbol	Conditions	Limits Min	Limits Max	Units
Responsivity	R	λ = 1060 nm	2.7×10^{5}		V/W
Spectral output noise voltage density	V_n	Δf=10 KHz (a) f=1.0 MHz (b) f=16,32 and 48 MHz		5.0×10^{-8} 1.0×10^{-7}	$V/(Hz)^{1/2}$
Output swing	V		1		V
Bandwidth	BW	3 db points	20×10^{6}		Hz
Recovery Time	t_{rev}	P_{opt}=500 mW,5 ns	660		ns
Rise time	t_r		18		ns
Fall time	t_f		18		ns
Power consumption	P_{in}			75	mW
Output impedance	Z_o	f= 800 Hz		50	ohms

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1/ The following conditions apply to all performance characteristics in Table I: V_b is adjusted to obtain $R \geq 2.7 \times 10^5$ V/W with V_{cc} = -6 V, -6 V.

3.15 Temperature cycling.- After being subjected to specified temperature cycling, there shall be no evidence of defects or damage to case, leads or seals or loss of marking legibility.

3.16 Mechanical shock.- After being subjected to a shock of 1500g for 0.5 msec, there shall be no evidence of defects or damage to leads or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.17 Vibration.- After being subjected to a vibration with a peak acceleration of 20g with a frequency range of 20 to 2000 Hz, there shall be no evidence of defects or damage to case, leads or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.18 Constant acceleration.- After being subjected to a constant acceleration of 5000g for 1 minute in each of its orientations, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.19 High temperature storage.- After being stored at a temperature of 35°C for 24 hours, the device shall be electrically operable (see 4.6.3(a)).

3.20 Operating life.- After being operated at 71°C for 1000 hours under normal operating conditions, the device shall be electrically operable (see 4.6.3(a)).

3.21 Moisture resistance.- After being subjected to the specified humidity and temperature cycling, there shall be no evidence of corrosion
92 of external metal surfaces. Also, the device shall be electrically operable (see 4.6.3(a)).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection.- Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection.- Inspection shall be classified as follows:

(a) First article inspection (does not include preparation for delivery (See 4.5).

(b) Quality conformance inspection. (See 4.6).

4.3 Test plan.- The contractor prepared Government-approved test plan, as cited in the contract, shall contain:

(a) Time schedule and sequence of examinations and tests.

(b) A description of the method of test and procedures.

(c) Identification and brief description of each inspection instrument and date of most recent calibration.

4.4 Screening.- Screening shall be conducted on all devices prior to first article and quality conformance inspection and shall be in accordance with Class B of Method 5004 of MIL-STD-883. The following additional criteria shall apply:

(a) Internal visual per Method 2017 of MIL-STD-883.

(b) Stabilization bake per Method 1008 except temperature shall be 85°C.

(c) Thermal shock (Method 1011 of MIL-STD-883 Condition A).

(d) Temperature cycling per Method 1010, Test Condition A, of MIL-STD-883.

(e) Mechanical shock shall be in accordance with MIL-STD-883, Method 2002, Condition B except there will be 2 shocks per orientation (12 shocks total) with a duration of 0.5 msec.

43 (f) Constant acceleration per Method 2001, Test Condition A, of MIL-STD-883.

(g) Seal (Method 1014 of MIL-STD-883).

(1) Fine Leak: per Test Condition A_1.

(2) Gross leak: per Test Condition C_1.

(h) Interim (pre-burn-in) electrical parameters shall consist of subgroup 1 of Table III.

(i) Burn-in (Method 1015 of MIL-STD-883).

(1) Test Condition B.

(2) T_a = 71°C minimum.

(j) Interim (post-burn-in) electrical parameters shall consist of subgroup 1 of Table III.

(k) Reverse bias burn-in and interim electrical test in accordance with 3.1.10 of Method 5004 of MIL-STD-883 may be omitted.

(l) Omit "Final electrical test" screen.

4.5 First article.- Unless otherwise specified in the contract, the first article inspection shall be performed by the contractor.

4.5.1 First article units. The contractor shall furnish 30 samples.

4.5.2 First article inspection.- The first article inspection shall consist of Table II and all the tests included in the Government-approved test plan to show compliance with the requirements of Section 3. No failures shall be permitted.

4.6 Quality conformance inspection.- Quality conformance inspection shall consist of tests specified in Tables III, IV and V.

4.6.1 Group A inspection.- Group A inspection shall consist of Table III.

4.6.2 Group B inspection.- Group B inspection shall consist of Table IV, and as follows:

(a) Units subjected to subgroup 2 shall be used for subgroup 3.

(b) Window (see 4.7.1).

4.6.3 Group C inspection.- Group C inspection shall consist of Table V and as follows:

94 (a) End point electrical parameters shall consist of subgroups 1, 4, and 7 of Table III.

(b) Operating life test: The module shall be operated with the voltages used in performing tests on subgroups 1, 2, 4, 7 and 8 (see Table III) and with a P_{opt} of 1 uW minimum.

4.7 Methods of examination and Test.- Methods of examination and test shall be as specified in the appropriate tables and as follows:

4.7.1 Window.- A visual inspection shall be made to insure there are no cracks or optical distortions in the window. The anti-reflection coating, if used, shall conform to the abrasion resistance requirement of MIL-C-675. These tests shall be performed prior to attaching the window to the case. (See 3.8).

4.7.2 Electrical.-

4.7.2.1 Responsivity (R).- A 1060 nm ± 5 nm source shall be used to measure the responsivity. The responsivity is defined as the ratio of the rms output voltage (V_{out}) of the module to the power incident on the detector (P_{opt}). The output of the module shall be terminated in a A.C. coupled 50 Ω load for this measurement.

TABLE II.- First article inspection

Test	Method	No. of Samples[2]				
		3	5	5	7	10
Group A Inspection	Table III [1]	To be performed on all units				
Group B Inspection	Table IV[1]					
Subgroup 1		X				
Subgroup 2		X				
Subgroup 3		X				
Subgroup 4		X				
Group C Inspection	Table V[1]					
Subgroup 1					X	
Subgroup 2			X			
Subgroup 3				X		
Subgroup 4						X

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[1] LTPD values do not apply for first article inspection.

[2] The number of samples specified for each column shall be subjected to all the tests of that column.

TABLE III.- Group A electrical test

MIL-STD-883 Method 5005 Table I Subgroup	Symbol	Test Method	Max	Min	LTPD
1	V_n	Para. 4.7.2.2 (a) f=1.0 MHz (b) f=16,32 and 48 MHz	 $5.0x10^{-8}V/(Hz)^{½}$ $1.0x10^{-7}V/(Hz)^{½}$		
static 25°C					13
1	P_{in}	Para. 4.7.2.6	75 mW		
1	Z_o	Method 4005 of MIL-STD-883	50 ohms		
2	V_n	Para.4.7.2.2 (at 1.0 MHz only)	$1.4x10^{-7}V(Hz)^{½}$		
2 static 71°C	P_{in}	Para. 4.7.2.6	75 mW		20
2	Z_o	Method 4005 of MIL-STD-883	50 ohms		
4	V_{out}	Para. 4.7.2.3		1 V	
4 25°C	BW	Para. 4.7.2.4		$20x10^6$Hz	13
4	t_{rev}	Para. 4.7.2.7	660 ns		
7	R	Para. 4.7.2.1		$2.7x10^5$ V/W	
7 25°C	t_r	Para. 4.7.2.5	18 ns		13
7	t_f	Para. 4.7.2.5	18 ns		
7	V_n	Para. 4.7.2.2 (at 1.0 MHz only)	$5.0x10^{-8}V/(Hz)^{½}$		
8	R	Para. 4.7.2.1		$2.7x10^5$V/W	
8 71°C,-50°C	t_r	Para. 4.7.2.5	18 ns		
8	t_f	Para. 4.7.2.5	18 ns		24
8	V_n	Para. 4.7.2.2 (at 1.0 MHz only)	$1.4x10^{-7}V/(Hz)^{½}$		

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Table IV.- Group B tests[1/]

Test	Reqt Para	MIL-STD-883 Method	MIL-STD-883 Condition	Class B LTPD
Subgroup 1				
Physical dimensions of Window (see 4.7.1)	3.3.2 3.8	2009		36
Subgroup 2				
(a) Resistance to solvents	3.9	2015	See [4/]	3 devices (no failures)
(b) Internal visual and mechanical	3.3	2014		1 device (no failure)
(c) Bond strength [2/]	3.10	2011		36
(1) Thermocompression			(1) Test Condition C or D	
(2) Ultrasonic or wedge			(2) Test Condition C or D	
(3) Flip-chip			(3) Test Condition F	
(4) Beam lead			(4) Test Condition H	
Subgroup 3				
Solderability [3/]	3.11	2003	Soldering temperature of 260 ± 10°C	36
Subgroup 4				
97 Lead integrity	3.12	2004	Test Condition B_2, lead fatigue	36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	

1/ Electrical reject devices from the same inspection lot may be used for all subgroups.

2/ Unless otherwise specified, at the manufacturer's option, test samples for bond strength may be selected randomly immediately following internal visual (Method 5004) prior to sealing.

3/ All devices must have been through the temperature time exposure in burn-in. The LTPD applies to the number of leads inspected except in no case shall less than three devices be used to provide the number of leads required.

4/ Except solvents used shall be: (a) Methyl alcohol, per O-M-232, Grade A, (b) Ethyl alcohol, per O-E-00760, Type 1, Grade A, (c) Isopropyl alcohol, per TT-I-735, Grade A, and (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) and one (1) part by volume of distilled water.

Table V.- Group C tests

Test	Reqt Para	MIL-STD-883 Method	MIL-STD-883 Condition	Class B LTPD
<u>Subgroup 1</u> [1/]				
Thermal shock	3.14	1011	Test Condition A as a minimum	
Temperature cycling	3.15	1010	Test Condition A	
Moisture resistance	3.3.4,3.21	1004		36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	
Visual examination [2/]	3.3			
End point electrical parameters (see 4.6.3(a))				
<u>Subgroup 2</u> [1/]				
Mechanical Shock	3.16	2002	Test Condition B	
Vibration, variable Frequency	3.17	2007	Test Condition A	
Constant acceleration	3.18	2001	Test Condition A	36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	
Visual examination [3/]	3.3			
End point electrical parameters (see 4.6.3(a))				
<u>Subgroup 3</u>				
High temperature [4/] storage	3.19	1008	$T_a = 85^{\circ}C$ for 24 hrs	24
End point electrical parameters (see 4.6.3(a))				
<u>Subgroup 4</u>				
Operating life [4/] (see 4.6.3(b))	3.20	1005	Test Condition B at $71^{\circ}C$	20
End point electrical parameters (see 4.6.3(a))				

[1/] Devices used for environmental tests in subgroup 1 may be used for mechanical tests in subgroup 2.

[2/] Visual examination shall be in accordance with method 2009.1 at a magnification of 5X to 10X.

[3/] Visual examination shall be performed at a magnification of 5X to 10X for evidence of defects or damage to case, leads, or seals resulting from testing (not fixturing). Such damage shall constitute a failure.

[4/] See 40.4 of appendix B of MIL-M-38510.

4.7.2.2 Spectral output noise voltage density (V_n).- The output noise voltage shall be measured at center frequencies of 1, 16, 32 and 48 MHz with Δf = 10 KHz or less. (The spectral output noise voltage density shall be defined as the ratio of output noise voltage to the square root of the bandwidth ($\sqrt{\Delta f}$). The output of the module will be terminated in a 50 ohm load for this measurement.

4.7.2.3 Output Swing (V_S). - A Gallium Indium Arsenide (GaInAs) LED (λ = 1060 nm $\mp$ 5 nm), modulated with a 50 ns pulse width and a repetition rate of 1 MHz or less, shall be used for this measurement. The power of the modulated source, incident on the detector, shall be varied by controlling the drive current. As the optical power is increased, the amplitude of the module output voltage where pulse clipping begins is defined as the upper limit of the output swing.

4.7.2.4 Module bandwidth (BW). The module bandwidth is defined as the difference between the upper and lower frequencies at which the module output is 3 db lower than the output at 100 KHz.

4.7.2.5 Rise and fall time (t_r, t_f).- The rise and fall time shall be measured using a GaInAs LED (λ = 1060 nm $\mp$ 5 nm) with a rise and fall time of less than 5 ns and a minimum pulse width of 50 ns. The rise time of the module shall be measured from the 10% to 90% point and fall time from the 90% to 10% point.

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4.7.2.6 Power consumption (P_{in}).- The normal operating voltage shall be applied to the module. The temperature of the module shall be varied over the operating range (-50°C to 71°C) and the input currents shall be monitored to insure that the power input does not exceed the value given by $P_{in} = \Sigma(i_n V_{cc} + i_n V_b) = 75$ mW. This test shall be performed with the optical port covered.

4.7.2.7 Recovery time (t_{rev}).- The SAPDM1 shall be biased so that the responsivity is equal to 2.7 x 10^5 V/W. A pulse optical input of λ = 1060 nm with a minimum power of .5W and a maximum pulse width of 5 ns shall be incident on the avalanche detector in the SAPDM1. The recovery time is the elapsed time between the 100 mV points of the module output pulse.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging and packing.- Units shall be prepared for delivery as specified in the contract.

6. NOTES

6.1 Abbreviations, symbols, and definitions.- The abbreviations, symbols, and definitions are as follows:

A	photodetector active area
BW	bandwidth
DR	dynamic range
Δf	bandwidth used in noise measurement
f	frequency
i_n	input current
LED	light emitting diode
m	modulation index
NEP	noise equivalent power
P_{av}	average optical input power
P_{in}	power consumption
P_{opt}	optical input power
R	responsivity
t_f	fall time
t_r	rise time
t_{rev}	recovery time
V_b	photodetector bias voltage
V_{cc}	amplifier operating voltage
V_n	spectral output noise voltage density
V_s	voltage output swing
λ	wavelength
Z_o	output impedance
V_{out}	rms output voltage

6.2 Noise equivalent power.- NEP is defined as follows:

$$NEP = V_n/R$$

6.3 Modulation index(m).- The modulation index is defined for cosinusoidal modulation at a radian frequency ω_m by

$$P_{opt} = P_{av} (1 - m \cos \omega_m t)$$

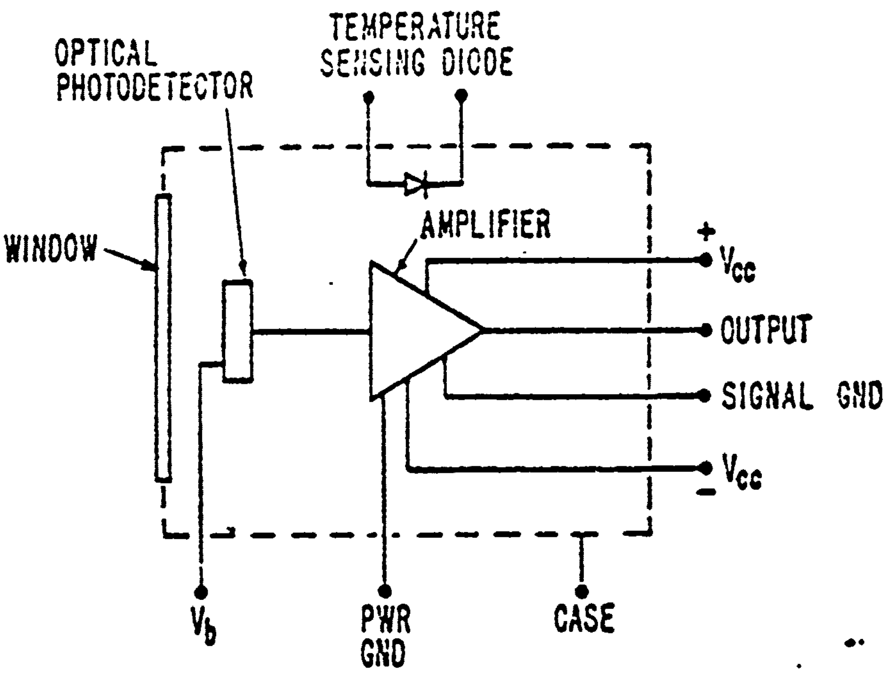
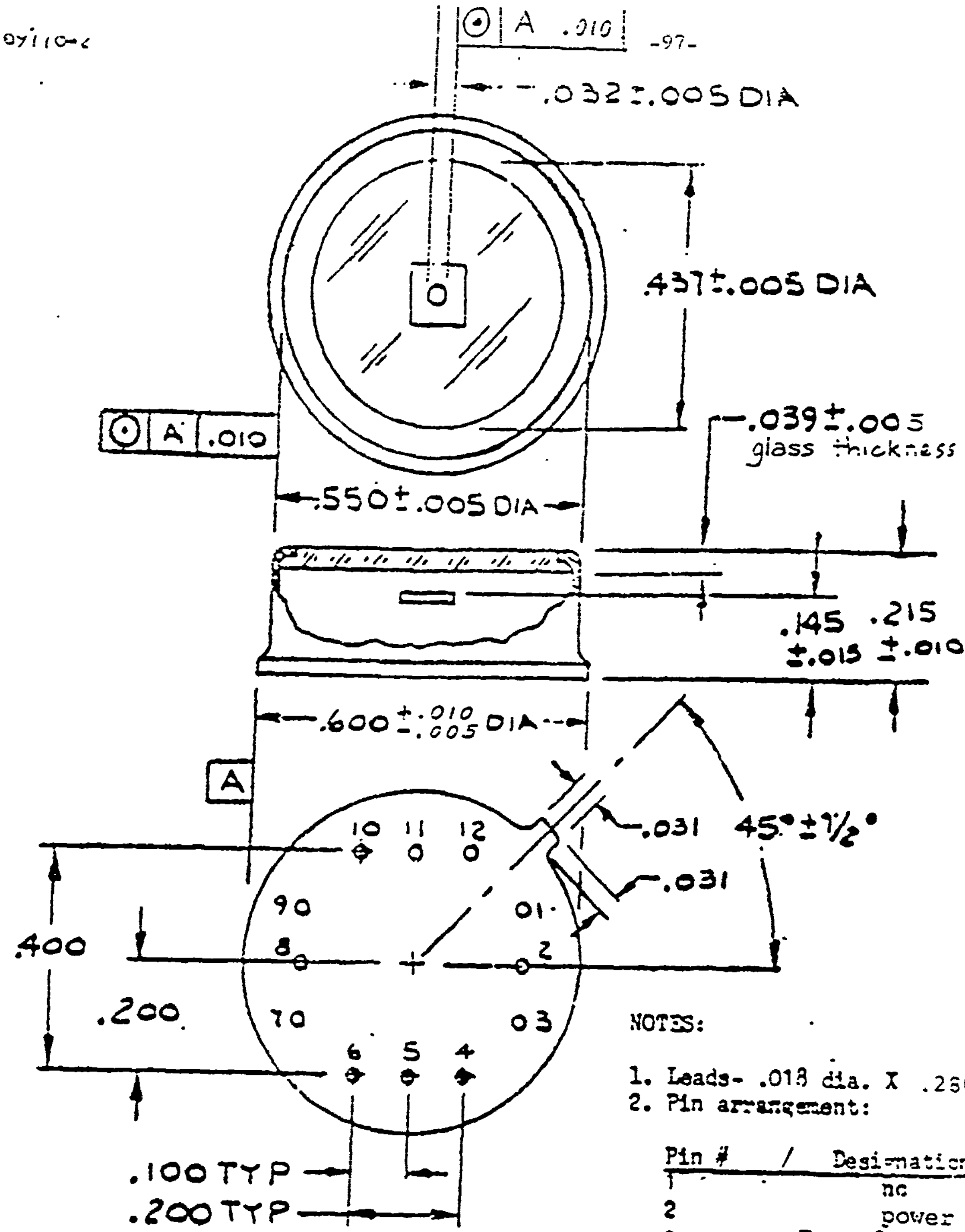


FIGURE 1. LOGIC DIAGRAM FOR PHOTODETECTOR MODULE



NOTES:

1. Leads- .018 dia. X .250 min. lg.
2. Pin arrangement:

Pin # /	Designation
1	nc
2	power ground
3	Temp.Sens.Diode Cathode
4	Temp.Sens.Diode Anode
5	V_{out}
6	case ground
7	$-V_{cc}$
8	nc
9	signal ground
10	nc
11	V_b
12	$+V_{cc}$

FIGURE 2. Physical dimensions.

ELECTRONICS COMMAND
TECHNICAL REQUIREMENTS

MMT-769776-3
6 August 1976
Revised 2 June 1978
and 29 Sep 79

SILICON AVALANCHE PHOTODETECTOR MODULE FOR FIBER OPTIC COMMUNICATIONS

1. SCOPE

1.1 Scope.- This specification covers the detail requirements for a Silicon Avalanche Photodetector Module (SAPDM2) for the detection of 820 nanometer (nm) radiation for fiber optic communication.

1.2 Device class.- Device shall be class B as defined in MIL-M-38510.

1.3 Maximum operating conditions.-

V_{cc} = +6V, -6V

V_b = 550 V

P_{in} = 100 mW

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposals, form a part of this specification to the extent specified herein:

SPECIFICATIONS

FEDERAL

O-E-00760	Ethyl Alcohol (Ethanol); Denatured Alcohol; Proprietary Solvents and Special Industrial Solvents.
O-M-232	Methanol (Methyl Alcohol).
TT-I-735	Isopropyl Alcohol.
MMM-A-131	Adhesive, Glass to Metal.
MMM-A-134	Adhesive, Epoxy Resin, Metal to Metal Structural Bonding.

MILITARY

MIL-C-675	Coating of Glass Optical Elements.
MIL-R-10509	Resistor, Fixed Film, (High Stability) General Specification for.
MIL-M-38510	Microcircuits, General Specification for.
MIL-C-39012	Connector, Coaxial, RF, General Specification for.

OTHER

MMT-769776-1	Silicon Pin Photodetector Module for Fiber Optic Communications.
SCS-467	Solid State Avalanche Detector.

STANDARDS

MILITARY

MIL-STD-883 Test Methods and Procedures for Microelectronics.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both title and number or symbol should be stipulated when requesting copies.)

3. REQUIREMENTS

3.1 Description of SAPDM2.- SAPDM2 is a high speed, high quantum efficiency device. This module is used for long distance fiber optic communications. This module is a hermetically sealed unit which operates over the temperature range from -50°C to 71°C. It contains a silicon avalanche photodiode and a high speed, low noise amplifier. The two external resistors which control responsivity are to be provided. The SAPDM2 has an optical input connector with a numerical aperture (N.A.) greater than 0.3. All radiation at the optical input of the optical connector within a cone of half angle of 17° will be incident on the photodetector. The silicon avalanche photodiode is optimized for a wavelength of 820 nm radiation.

3.2 Performance characteristics.- Performance characteristics shall be as specified in Tables I, III, IV and V.

3.3 Design, construction, and physical dimensions.- The design, construction and physical dimensions shall be as specified in MIL-M-38510 and herein. The following exceptions shall apply to paragraph 3.5.1 of MIL-M-38510

(a) Epo-Tek H20E (Epoxy Technology Inc., Watertown, MA) may be used to mount the chip devices to the substrate of the silicon pin photodetector-preamplifier hybrid circuit.

(b) Adhesives conforming to Federal Specifications MMM-A-131 and MMM-A-134 may be used (where applicable) for package sealing.

(c) A Government approved epoxy may be used for attachment of the substrate to the package.

(d) Epo-Tek H70E epoxy may be used for internal attachment of components.

The above exceptions shall apply only if the materials specified are used.

3.3.1 Logic diagram.- The logic diagram shall be as specified on Figure 1.

3.3.2 Case outlines.- The case outlines shall be in accordance with Figures 2 and 3, or in a modification submitted by the contractor for Government approval. The connector shall be a MIL-C-39012/61 receptacle modified to incorporate an optical pipe and detector either as shown in Figure 2A or in a modification submitted by the contractor for Government approval. The connector, when incorporated in the photodetector modules, shall have no adverse effect on the performance of the modules as specified.

3.3.3 Lead material and finish.- The lead material shall be Type A or B and lead finish shall be gold plate, per paragraphs 3.5.6.1 and 3.5.6.2, respectively, of MIL-M-38510.

3.3.4 Metals.- External metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion.

3.3.5 External resistors.- The two external resistors which control the temperature compensated biasing circuit (TCU) (see Fig. 1) shall be supplied with the SAPDM2. They shall conform to MIL-R-10509.

3.4 Electrical performance characteristics.- The electrical performance characteristics are as specified in Table I, and apply over the full ambient operating temperature range of -50°C to 71°C unless otherwise specified.

3.5 Rebonding.- Rebonding shall be in accordance with paragraph 3.7.1.2 of MIL-M-38510.

3.6 Marking.- Marking shall be in accordance with MIL-M-38510 except the following information shall be marked on each microcircuit.

(a) Date Code.
(b) Manufacturer's identification.
(c) Part number:MMT-769776-3.
(d) Specified values of external resistors, R_1 and R_2.

3.7 Interchangeability.- All modules and their specified external resistors (see 3.3.5), having the same manufacturer's part number, shall be interchangeable with each other with respect to fit, form and function.

3.8 Anti-reflection coating.- The detector and light pipe may be anti-reflection coated to insure a maximum transmission for λ=820 nm.

3.9 Resistance to solvents.- When the device is subjected to solvents, there shall be no evidence of: (a) mechanical damage, (b) deterioration of the materials or finishes, and (c) illegibility of case marking.

3.10 Bond strength.- The bond shall meet the minimum bond strength requirements listed in Table I of method 2011.1 of MIL-STD-883.

3.11 Solderability.- All electrical terminations shall be solderable.

3.12 Lead integrity.- With a force of 8 ounces applied to the leads for three 90 $\pm$ 5 degree arcs of the case, there shall be no evidence of breaking.

3.13 Seal.- For fine leak, the maximum allowable leakage rate shall not exceed $5x10^{-7}$ atm cc/sec. For gross leak, the maximum allowable leakage rate shall not exceed $1x10^{-5}$ atm cc/sec.

3.14 Thermal shock.- After being subjected to specified temperature conditioning, there shall be no evidence of defects or damage to case, leads, or seals or loss of marking legibility.

3.15 Temperature cycling.- After being subjected to specified temperature cycling, there shall be no evidence of defects or damage to case, leads, or seals or loss of marking legibility.

3.16 Mechanical shock.- After being subjected to a shock of 1500g for 0.5 msec, there shall be no evidence of defects or damage to leads or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.17 Vibration.- After being subjected to a vibration with a peak acceleration of 20g with a frequency range of 20 to 2000 Hz, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.18 Constant acceleration.- After being subjected to a constant acceleration of 5000g for 1 minute in each of its orientations, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see 4.6.3(a)).

3.19 High temperature storage.- After being stored at a temperature of 85°C for 24 hours, the device shall be electrically operable (see 4.6.3(a)).

3.20 Operating life.- After being operated at 71°C for 1000 hours under normal operating bias conditions, the device shall be electrically operable (see 4.6.3(a)).

3.21 Moisture resistance.- After being subjected to the specified humidity and temperature cycling, there shall be no evidence of corrosion of external metal surfaces. Also, the device shall be electrically operable (see 4.6.3(a)).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.- Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

Table I.- Electrical performance characteristics[1/]

Characteristic	Symbol	Conditions	Limits Min	Limits Max	Units
Responsivity	R	λ=820 nm	1.3×10^5		V/W
Spectral Output Noise Voltage Density	V_n	Δf= 10 KHz (a) f=1 MHz (b) f=16,32 and 48 MHz		5.0×10^{-8} 1.0×10^{-7}	$V/(Hz)^{1/2}$
Output Swing	V_{out}		1		V
Bandwidth	BW	3 db points	1.6×10^7		Hz
Rise Time	t_r			22	ns
Fall Time	t_f			22	ns
Power consumption	P_{in}			100	mW
Output impedance	Z_o	f = 800 Hz.		50	ohms

[1/] The following conditions apply to all performance characteristics in Table I: V_b is adjusted to obtain $R \geq 1.3 \times 10^5$ V/W with V_{cc} = +6V, -6V.

4.2 Classification of inspection.- Inspection shall be classified as follows:

(a) First article inspection (does not include preparation for delivery). (See 4.5).

(b) Quality conformance inspection. (See 4.6).

4.3 Test plan.- The contractor prepared Government-approved test plan, as cited in the contract, shall contain:

(a) Time schedule and sequence of examinations and tests.

(b) A description of the method of test and procedures.

(c) Identification and brief description of each inspection instrument and date of most recent calibration.

4.4 Screening.- Screening shall be conducted on all devices prior to first article and quality conformance inspection and shall be in accordance with Class B of Method 5004 of MIL-STD-883. The following additional criteria shall apply:

(a) Internal visual per Method 2017 of MIL-STD-883.

(b) Stabilization bake per Method 1008 except temperature shall be 85°C.

(c) Thermal shock (Method 1011 of MIL-STD-883 Condition A).

(d) Temperature cycling per Method 1010, Test Condition A, of MIL-STD-883.

(e) Mechanical shock shall be in accordance with MIL-STD-883, Method 2002, Condition B except there will be 2 shocks per orientation (12 shocks total) with a duration of 0.5 msec.

(f) Constant acceleration per Method 2001, Test Condition A, of MIL-STD-883.

(g) Seal (Method 1014 of MIL-STD-883).

(1) Fine leak: per Test Condition A_1.

(2) Gross leak: per Test Condition C_1.

(h) Interim (pre-burn-in) electrical parameters shall consist of subgroup 1 of Table III.

(i) Burn-in (Method 1015 of MIL-STD-883).

(1) Test Condition B.

(2) T_a = 71°C minimum.

(j) Interim (post-burn-in) electrical parameters shall consist of subgroup 1 of Table III.

(k) Reverse bias burn-in and interim electrical test in accordance with 3.1.10 of Method 5004 of MIL-STD-883 may be omitted.

(l) Omit "Final electrical test" screen.

4.5 First article.- Unless otherwise specified in the contract, the first article inspection shall be performed by the contractor.

4.5.1 First article units.- The contractor shall furnish 30 samples.

4.5.2 First article inspection.- The first article inspection shall consist of Table II and all the tests included in the Government-approved test plan to show compliance with the requirements of Section 3. No failures shall be permitted.

4.6 Quality conformance inspection.- Quality conformance inspection shall consist of tests specified in Tables III, IV and V.

4.6.1 Group A inspection.- Group A inspection shall consist of Table III.

4.6.2 Group B inspection.- Group B inspection shall consist of Table IV, and as follows:

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(a) Units subjected to subgroup 2 shall be used for subgroup 3.

(b) Interchangeability (See 4.7.1).

(c) Anti-reflection coating. (See 4.7.2).

4.6.3 Group C inspection.- Group C inspection shall consist of Table V and as follows:

(a) End point electrical parameters shall consist of subgroups 1, 4 and 7 of Table III.

(b) Operating life test: The module shall be operated with the voltages used in performing tests on subgroups 1, 2, 4, 7 and 8 of Table III and with a P_{opt} of 1 uW minimum.

4.7 Methods of examination and test.- Methods of examination and test shall be as specified in the appropriate tables and as follows:

4.7.1 Interchangeability.- The module shall mate with the specified fiber optic connector. (See Figure 3).

4.7.2 Anti-reflection coating.- The coating, if used, shall conform to the abrasion resistance requirement of MIL-C-675. This test shall be performed on the light pipe prior to final assembly of the module.

Table II.- First article inspection

Test	Method	No. of samples [2]				
		3	5	5	7	10
Group A Inspection	Table II [1]	To be performed on all units				
Group B Inspection	Table III [1]					
Subgroup 1		X				
Subgroup 2		X				
Subgroup 3		X				
Subgroup 4		X				
Group C Inspection	Table IV [1]					
Subgroup 1					X	
Subgroup 2			X			
Subgroup 3				X		
Subgroup 4						X

[1] LTPD values do not apply for first article inspection.

[2] The number of samples specified for each column shall be subjected to all the tests of that column.

Table III.- Group A electrical test

MIL-STD-883 Table I Method 5005 Subgroup	Symbol	Test Method	Max	Min	LTPD
1	V_n	Para. 4.7.3.2 (a) f=1 MHz (b) f=16,32 and 48 MHz	 $5.0 \times 10^{-8} V/(Hz)^{1/2}$ $1.0 \times 10^{-7} V/(Hz)^{1/2}$		13
static 1 25°C	P_{in}	Para. 4.7.3.6	100 mW		
1	Z_o	Method 4005 of MIL-STD-883	50 ohms		
2	V_n	Para. 4.7.3.2 (at 1 MHz only)	$14 \times 10^{-8} V/(Hz)^{1/2}$		20
static 2 71°C	P_{in}	Para. 4.7.3.6	100 mW		
2	Z_o	Method 4005 of MIL-STD-883	50 ohms		
4	V_{out}	Para. 4.7.3.3		1 V	
4 25°C	BW	Para. 4.7.3.4		1.6×10^{7} Hz	13
7	R	Para. 4.7.3.1		1.3×10^{6} V/W	
7 25°C	t_r	Para. 4.7.3.5	22 ns		13
7	t_f	Para. 4.7.3.5	22 ns		
7	V_n	Para. 4.7.3.2 (at 1 MHz only)	$5.0 \times 10^{-8} V/(Hz)^{1/2}$		
8	R	Para. 4.7.3.1		1.3×10^{6} V/W	
8 71°C,-50°C	t_r	Para. 4.7.3.5	22 ns		24
8	t_f	Para. 4.7.3.5	22 ns		
8	V_n	Para. 4.7.3.2 (at 1 MHz only)	$14 \times 10^{-8} V/(Hz)^{1/2}$		

Table IV.- Group B tests[1]

Test	Reqt Para.	MIL-STD-883		Class B LTPD
		Method	Condition	
Subgroup 1				
Physical dimensions	3.3.2	2009		
Interchangeability (see 4.7.1)	3.7			36
Anti-reflection coating (See 4.7.2)	3.8			
Subgroup 2				
(a) Resistance to solvents	3.9	2015	See 4/	3 devices (no failures)
(b) Internal visual and mechanical	3.3	2014		1 device (no failure)
(c) Bond strength 2/	3.10	2011		36
(1) Thermocompression			(1) Test Condition C or D	
(2) Ultrasonic or wedge			(2) Test Condition C or D	
(3) Flip-chip			(3) Test Condition F	
(4) Beam Lead			(4) Test Condition H	
Subgroup 3				
Solderability[3]	3.11	2003	Soldering temperature of 260 ± 10°C	36
Subgroup 4				
Lead Integrity	3.12	2004	Test Condition B_2, lead fatigue	
Seal	3.13	1014		36
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	

1/ Electrical reject devices from the same inspection lot may be used for all subgroups.

2/ Unless otherwise specified, at the manufacturer's option, test samples for bond strength may be selected randomly immediately following internal visual (Method 5004) prior to sealing.

3/ All devices must have been through the temperature/time exposure in burn-in. The LTPD applies to the number of leads inspected except in no case shall less than three devices be used to provide the number of leads required.

4/ Except solvents used shall be: (a) Methyl alcohol, per O-M-232, Grade A, (b) Ethyl alcohol, per O-E-00760, Type 1, Grade A, (c) Isopropyl alcohol, per TT-I-735, Grade A, and (d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) and one (1) part by volume of distilled water.

Table V.- Group C tests

Test	Reqt Para	MIL-STD-883 Method	MIL-STD-883 Condition	Class B LTPD
Subgroup 1 1/				
Thermal shock	3.14	1011	Test Condition A as a minimum	
Temperature cycling	3.15	1010	Test Condition A	
Moisture resistance	3.3.4, 3.21	1004		36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	
Visual examination 2/	3.3			
End point, electrical parameters (see 4.6.3(a))				
Subgroup 2 1/				
Mechanical shock	3.16	2002	Test Condition B	
Vibration, variable frequency	3.17	2007	Test Condition A	
Constant acceleration	3.18	2001	Test Condition A	36
Seal	3.13	1014		
(a) Fine			Test Condition A_1	
(b) Gross			Test Condition C_1	
Visual examination 3/	3.3			
End Point electrical parameters (see 4.6.3(a))				
Subgroup 3				
High temperature 4/ storage	3.19	1008	$T_a = 85^{\circ}C$ for 24 hrs	24
End point electrical parameters (see 4.6.3(a))				
Subgroup 4				
Operating life 4/ (see 4.6.3(b))	3.20	1005	Test Condition B at $71^{\circ}C$	20
End point electrical parameters (see 4.6.3(a))				

1/ Devices used for environmental tests in subgroup 1 may be used for mechanical tests in subgroup 2.

2/ Visual examination shall be in accordance with method 2009.1 at a magnification of 5X to 10X.

3/ Visual examination shall be performed at a magnification of 5X to 10X for evidence of defects or damage to case, leads, or seals resulting from testing (not fixturing). Such damage shall constitute a failure.

4/ See 40.4 of appendix B of MIL-M-38510.

4.7.3 Electrical.-

4.7.3.1 Responsivity (R).- An 820 nm ± 5 nm source shall be used to measure the responsivity. The responsivity is defined as the ratio of the rms output voltage (V_{out}) of the module to the power incident on the detector (P_{opt}). The output of the module shall be terminated in an A.C. Coupled 50 Ω load for this measurement.

4.7.3.2 Spectral output noise voltage density (V_n).- The output noise voltage shall be measured at center frequencies of 1, 16, 32 and 48 MHz with Δf = 10 KHz or less. (The spectral output noise voltage density shall be defined as the ratio of output noise voltage to the square root of the bandwidth ($\sqrt{\Delta f}$).) The output of the module will be terminated in a 50 ohm load for this measurement.

4.7.3.3 Output Swing (V_s).- A Gallium Aluminum Arsenide (GaAlAs) LED (λ = 820 nm ± 5 nm), modulated with a 50 ns pulse width and a repetition rate of 1MHz or less, shall be used for this measurement. The power of the modulated source, incident on the detector, shall be varied by controlling the drive current. As the optical power is increased, the amplitude of the module output voltage where pulse clipping begins is defined as the upper limit of the output swing.

4.7.3.4 Module bandwidth (BW).- The module bandwidth is defined
115 as the difference between the upper and lower frequencies at which the module output is 3db lower than the output at 100 KHz.

4.7.3.5 Rise and fall time (t_r , t_f).- The rise and fall time shall be measured using a LED (λ = 820 nm ± 5 nm) with a rise and fall time of less than 5 ns and a minimum pulse width of 100 ns. The rise time of the module shall be measured from the 10% to 90% point and fall time from the 90% to 10% point.

4.7.3.6 Power consumption (P_{in}).- The normal operating voltage shall be applied to the module. The temperature of the module shall be varied over the operating range (-50°C to 71°C) and the input currents shall be monitored to insure that the power input does not exceed the value given by $P_{in} = \Sigma(i_n V_{cc} + i_n V_b) = 100$ mW for the photodetector module and temperature compensated biasing circuit. This test shall be performed with the optical port covered.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging and packing.- Units shall be prepared for delivery as specified in the contract.

6. NOTES

6.1 Abbreviations, symbols and definitions.- The abbreviations, symbols, and definitions are as follows:

Δf	bandwidth used in noise measurements
BW	bandwidth
f	frequency
i_n	input current
LED	light emitting diode
m	modulation index
NEP	noise equivalent power
P_{pk}	peak optical input power
P_{av}	average optical input power
P_{in}	power consumption
P_{opt}	optical input power
R	responsivity
T_a	ambient temperature
t_f	fall time
t_r	rise time
V_b	detector bias voltage
V_{cc}	amplifier operating voltage

V_n spectral output noise voltage density

V_s output swing

λ wavelength

Z_o output impedance

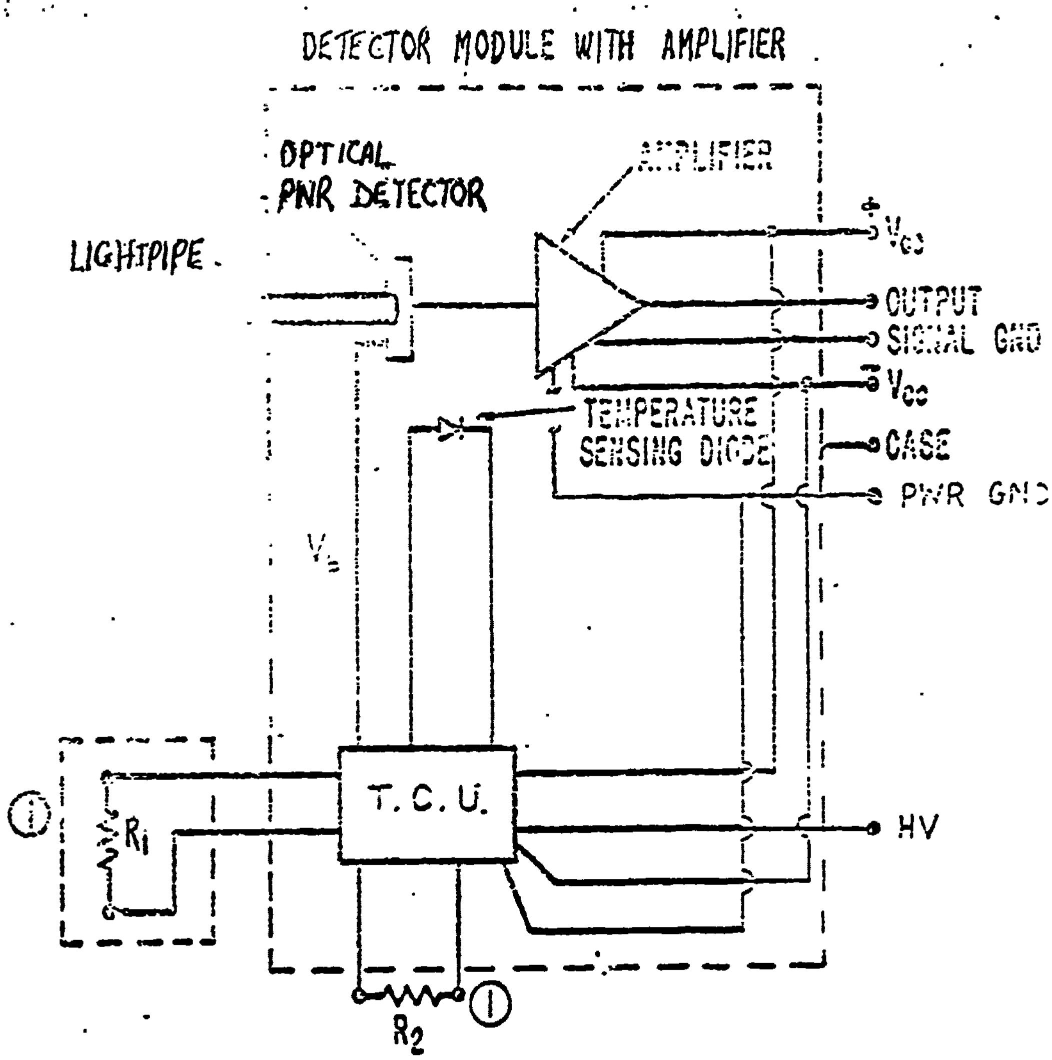
6.2 Noise uivalent power.- NEP is defined as follows:

$$NEP = V_n/R$$

6.3 Modulation index (m).- The modulation index is defined for cosinuscidal modulation at a radian frequency ω_m by

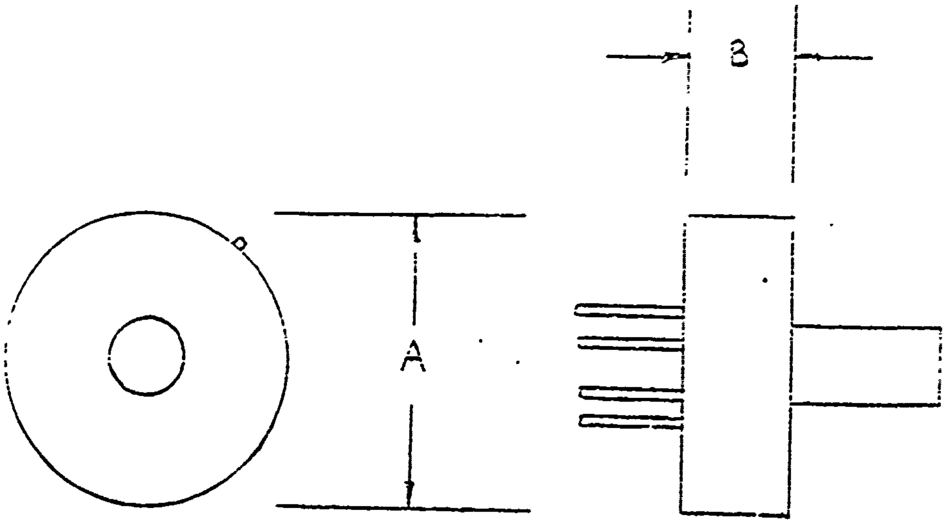
$$P_{opt} = P_{av}(1 + m \cos \omega_m t)$$

6.4 Fiber optic connector.- A fiber optic connector to be used to mate with the photodetector module is shown in Figure 4. The connector is a MIL-C-39012/55 plug modified to incorporate the optical fiber.



NOTE : (1) EXTERNAL RESISTORS TO OBTAIN DESIRED RESPONSIVITY.

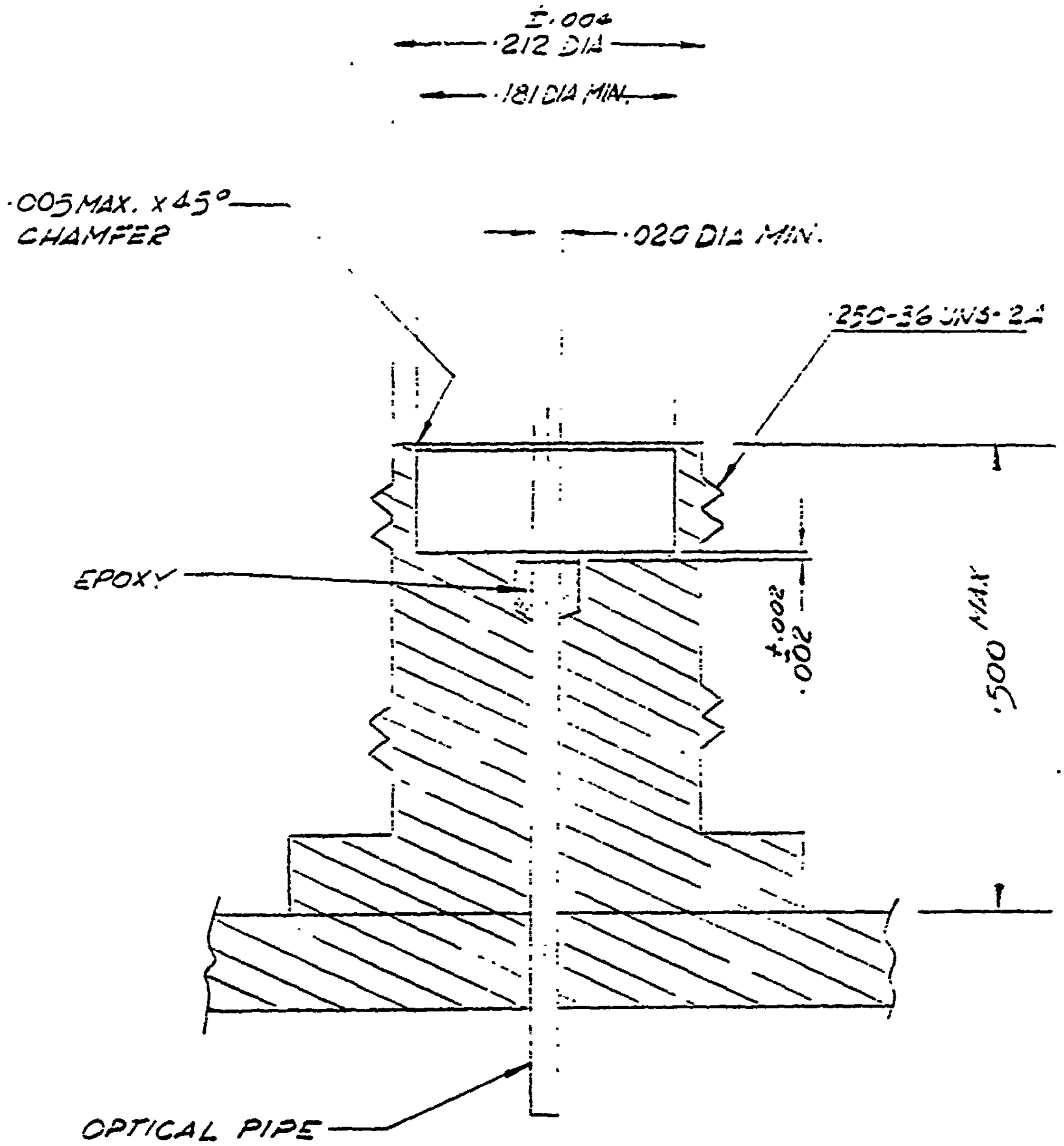
FIGURE 1. LOGIC DIAGRAM FOR SAPDH2



Symbol	Inches [1/] Min	Max	MILLIMETERS MIN.	MAX.
A	-	1"	-	25.4
B	-	.5"	-	12.7

[1/] **Actual dimensions** may be much smaller than maximum.

Figure 2. CASE OUTLINE



NOTES:

1. Outline of Optical Connector is shown in Figure 5.

Fig. 3 - OPTICAL CONNECTOR

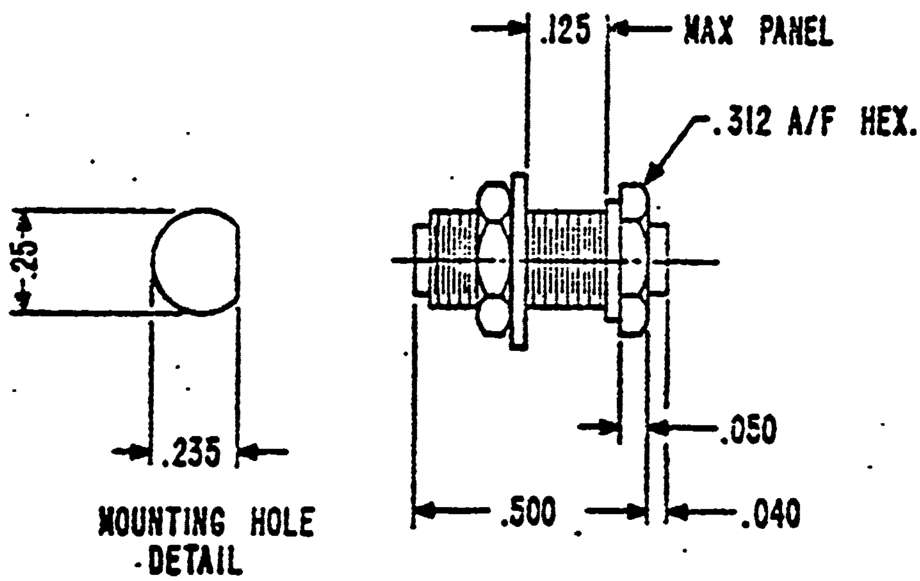
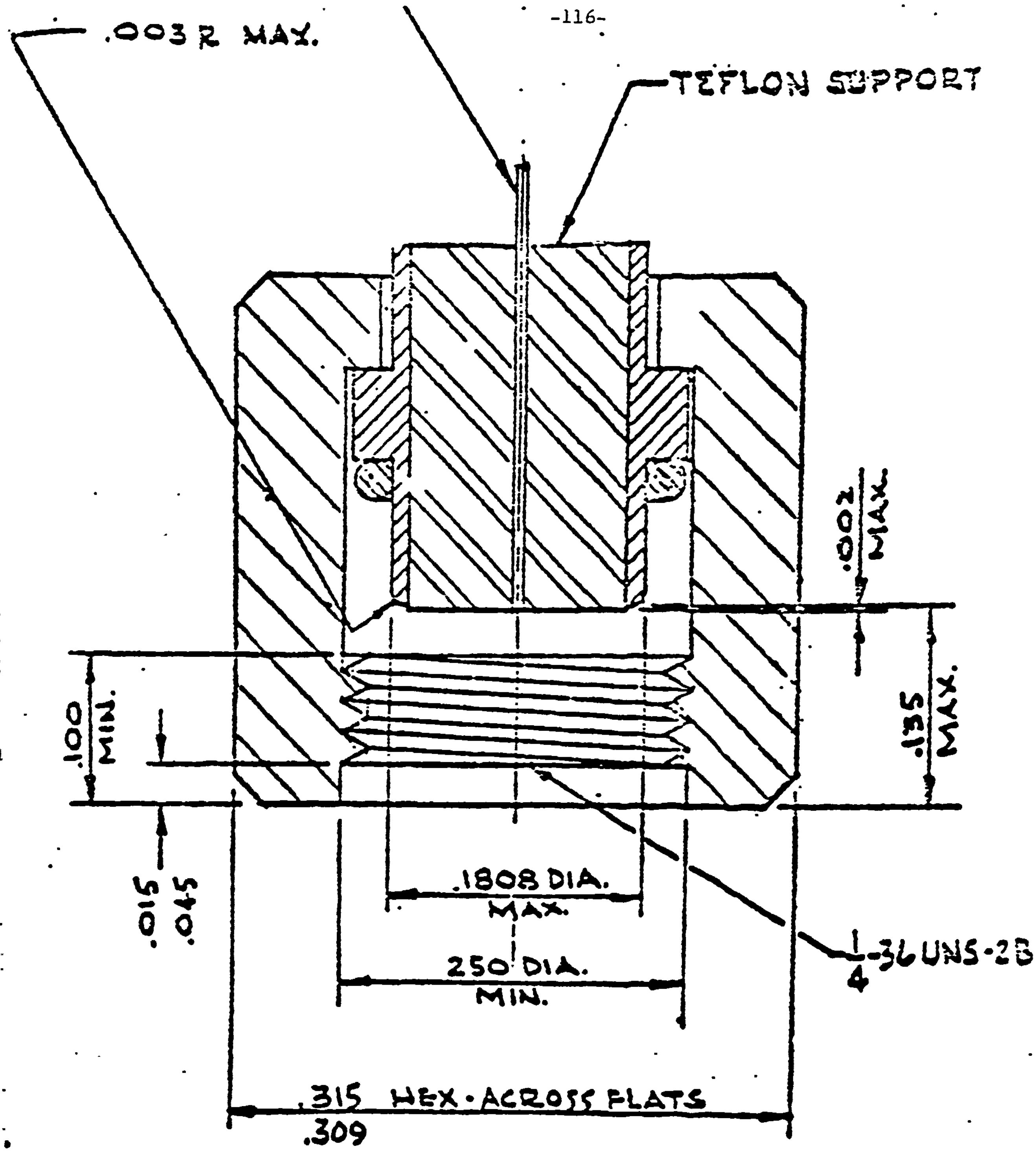


FIGURE 5. MOUNTING DETAIL FOR PROPOSED OPTICAL CONNECTOR (MODIFIED VERSION OF STANDARD BULKHEAD TYPE SMA CONNECTOR)



(THIS PART NOT SUPPLIED BY CONTRACTOR).

FIG 4. FIBER CONNECTOR

8.1.7 Confirmatory Samples Fabrication

Fabrication of the confirmatory samples proceeded uneventfully, free of technical problems, but somewhat delayed by problems experienced in the procurement of parts, particularly the thick film circuit. The test plan according to which these units were qualified appears after this section.

During the test sequence, all specifications were met, with the exception that there was a single failure during one of the tests.

A case ground lead separated from a base on one of the SAPDM-1 units, during the test for lead bending integrity, which specified three 90° cycles. It was established that a definite problem existed on several lots of bases supplied by a particular vendor, Tekform. In fairness to the vendor, the bases affected had not been purchased to the MIL-S requirement. The tests showed a significant probability of failure at the required LTPD level. It was decided to save the long lead time involved in re-ordering by selecting bases from the best lots for the pilot production run. At the same time, new bases were ordered to the correct specification of reliability. It was decided to regard the base as an item which could be qualified separately, so that in the event of a pilot production run failure, the replacement parts could be evaluated subsequently to demonstrate compliance.

8.1.8 PRODUCT ASSURANCE, TEST, DEMONSTRATION AND EVALUATION PLAN

SAPDM1

SECTION 1

GROUP 'A' TESTING

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8.1.8.1 Test Equipment and Calibrations

ITEM	CAL DATES	(WEEK/YEAR)
Light Sources as shown in Fig. 1	-	-
Pulse Generator HP 8015A	29/78	(29/79)
± 6.0 VDC Supply HP 6205B	29/78	(29/79)
Variable HVDC Supply Keithley 240A	29/78	(29/79)
0-10 mA Meters (2)	29/78	(29/79)
0-25 μA Meter (1)	29/78	(29/79)
DVM Keithley 160	29/78	(29/79)
RMS Voltmeter HP3403C	09/78	(09/79)
Oscilloscope HP1715A	29/78	(29/79)
Preamplifier HP8447A	40/78	(40/79)
Spectrum Analyzers HP8552/3B	30/78	(30/79)
X-Y Recorder HP7004B	09/78	(09/79)

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8.1.8.2 EQUIPMENT SPECIFICATIONS

Specification for LED Source

LED - RCA TYPE C30116 (λ = 1.06 μm)

DRIVER - HP 8015A Pulse Generator

Specification for reference power monitor

PIN PHOTODIODE/HYBRID PREAMPLIFIER-FET INPUT C30899

Responsivity - 2.5×10^5 v/w min at $\lambda = 1060 \pm 5$ nm
NEP - 10^{-12} W/Hz$^{1/2}$ Max at $\lambda = 1060 \pm 5$ nm
RESPONSE TIME - 3×10^{-6} s Max.

The power monitor is calibrated for responsivity by reference to a standard detector of spectral response established by an independent laboratory.

Specification for Optical System

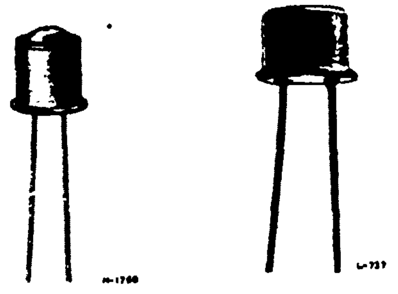
LIGHT SOURCE - EALING OPTIMOD 28-8449
CHOPPER - BULOVA TUNING FORK 800 Hz
OPTICS - EALING REFLECTING OBJECTIVE X15, -250506
FILTERS - BANDPASS FWHM 100Å

The control of incident radiation power is achieved by adjustment of separation between source and entrance pupil of the optical system.

Developmental Types

C30116, C30116/F

Gallium Indium Arsenide Types for Pulsed or Continuous DC Operation



C30116
OP-17 Package

C30116/F
Modified
OP-17 Package

- Wavelength of Peak Radiant Intensity – 1060 nanometers
- Total Radiant Flux at I_F = 50 mA (Continuous Service) – 0.1 mW minimum, 0.2 mW typical
- Hermetically-Sealed Two Lead "OP-17" Packages
- Peak Radiant Flux (Pulsed Service) – 10 mW typical at i_F = 5 A
- Half-Angle Beam Spread at 50% Intensity Points – Type C30116 - 12 degrees, Type C30116/F - 30 degrees

RCA Developmental Types C30116 and C30116/F are gallium indium arsenide solid state diodes which emit, when forward biased, a narrow beam of radiant flux at a wavelength of 1060 nanometers. The two diodes differ in that the emitting source of the C30116 is a GaInAs pellet assembled using a glass lens to produce the beam pattern while the C30116/F has a flat glass window (no lens).

These infrared emitting diodes are designed for a wide variety of industrial and military applications including YdYAG laser simulation and optical communications.

Variants of these devices can be supplied with a removable cap on special request.

Maximum Ratings, Absolute-Maximum Values

Continuous DC Operation:		
At case temperatures up to +50° C	50	mA
At case temperatures above +50° C	See Figure 5	
Peak Reverse Voltage, V_{RM}	2	V
Pulse Operation:		
Peak Forward Current, I_{FM}:		
At t_w = 1.0 μs, du = 0.1%	10	A
Temperature:		
Storage, T_{stg}	−40 to +150	°C
Operating, Case, T_C	−40 to +125	°C
Soldering:		
For 5 seconds	200	°C

Characteristics
At Case Temperature T_C = 27° C

	Min.	Typ.	Max.	Units
Continuous Service:				
Forward Voltage Drop, V_F:				
At I_F = 50 mA	–	3	–	V
Radiant Flux, Φ:				
At I_F = 50 mA	0.1	0.2	–	mW
Pulsed Service:				
For t_w = 1 μs, du = 0.05%, and prr = 500 p/s				
Peak Radiant Flux, Φ_M:				
At i_F = 5 A	–	10	–	mW
Peak Forward Voltage, v_{FM}:				
At i_F = 5 A	–	12	–	V
Switching Characteristics:				
Rise time of emitted pulse, t_r (10% to 90%)	–	<10	–	ns
Fall time of emitted pulse, t_f (90% to 10%)	–	<10	–	ns
Beam Characteristics:				
For Continuous or Pulse Operation				
Wavelength of Peak Radiant Intensity	1030	1060	1090	nm
Spectral Line Width Between Half Intensity Points	–	60	–	nm

For further information or application assistance on these devices, contact your RCA Sales Representative or write Solid State Electro Optics Marketing, RCA, Lancaster, PA 17604.

Printed in U.S.A./8-78
C30116, C30116/F
Supersedes 3-75

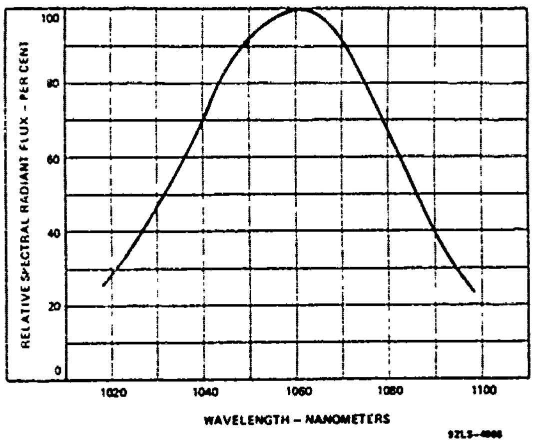


Figure 1 — Typical Spectral Radiant Flux

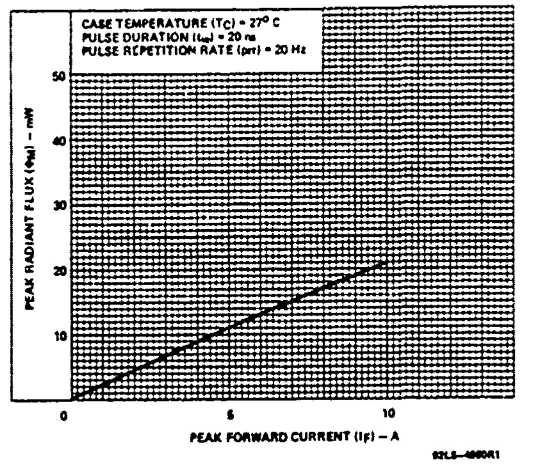


Figure 4 — Peak Radiant Flux vs Peak Forward Current

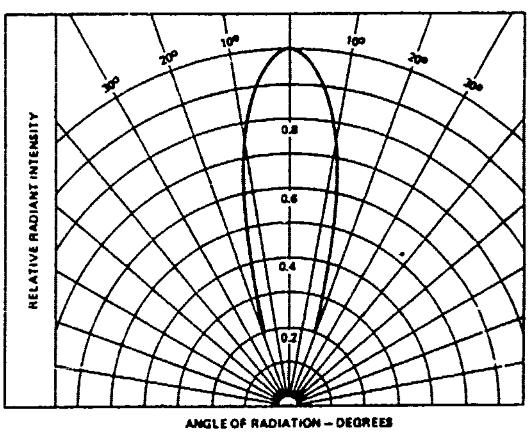


Figure 2 — Typical Radiant Intensity vs Angle From Central Axis of Diode for Type C30116

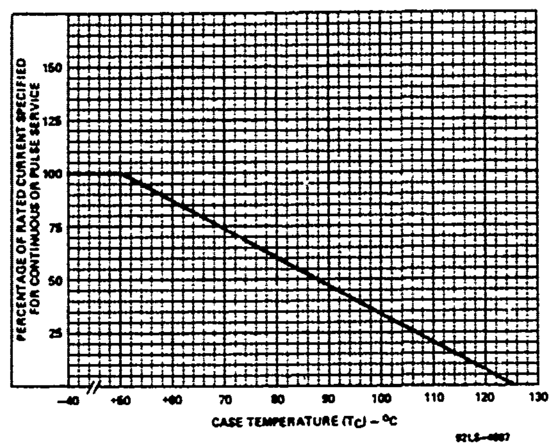


Figure 5 — Current Derating Curve

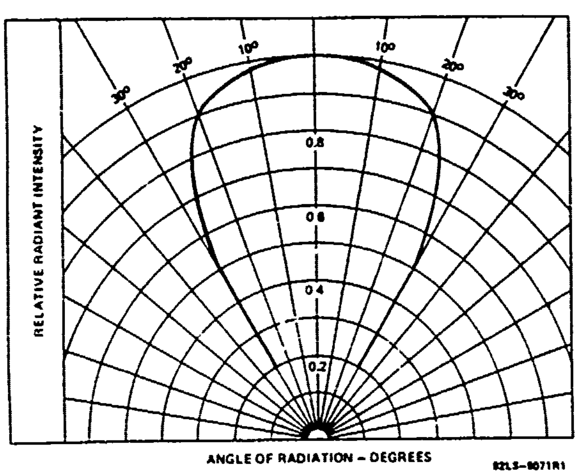
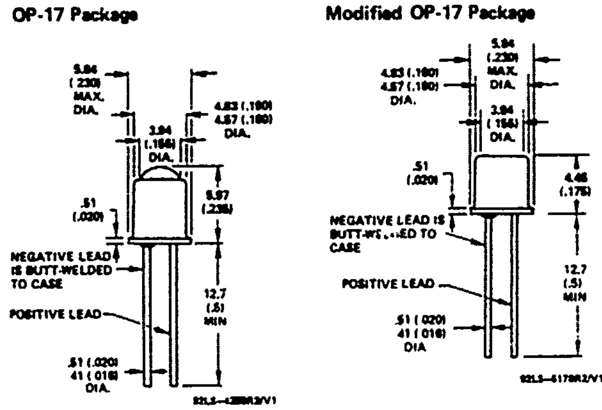


Figure 3 — Typical Radiant Intensity vs Angle From Central Axis of Diode for Type C30116/F

OP-17 Package

Modified OP-17 Package



Type C30116

Type C30116/F

Dimensions in millimeters Dimensions in parentheses are in inches.

Figure 6 — Dimensional Outlines

8.1.8.3. Description of Test Methods

Responsivity

The module shall be illuminated with a source of wavelength 1060 ± 5 nm, obtained by filtering of a tungsten filament source. The radiation shall be chopped at a frequency of 800 Hz. (The power incident on the detector (P_{opt}) shall be measured using a standard reference detector). The bias voltage on the module is increased until the responsivity, defined as the ratio of the rms output voltage (V_{out}) to P_{opt}, attains the required value. The output of the module shall be A.C. coupled to a 50 ohm load for this measurement. The bias voltage (V_{DR}) is recorded in the data log column G. The required value of responsivity will be 3.4×10^5 v/w at 22 ± 5°C, and 2.7×10^5 v/w at 71 ± 5°C and -50 ± 5°C. (Test Method G).

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Reverse Voltage Breakdown

With the module in the dark, the reverse bias voltage is increased until a dark current of 10 µA flows through the photodiode. An external 100 KΩ load shall be used for this measurement. The breakdown voltage (V_{DRB}) is recorded in the data log column A. (Test Method A).

Output Offset Voltage

With the detector in the dark, the reverse bias voltage is set to 100 volts below V_{DRB}. The voltage appearing at the module output is the preamplifier output offset voltage (V_{OO}). This is recorded in the data log column B. (Test Method B).

Power Consumption

With the detector in the dark, the reverse bias voltage is set to V_{DRB} - 100. With $\pm V_{cc} = \pm 6.0$ volts, the currents flowing through the $+V_{cc}$ and $-V_{cc}$ rails shall be measured and designated I^+ and I^- respectively. These currents are recorded in the data log columns C and D. The dark current I_D flowing in the photodiode will be measured. The value of P_{in}, defined as

$$6(I^+ + I^-) + I_D(V_{DRB} - 100) = P_{in}$$

shall not exceed 75 mW, over the temperature range of $-50^\circ C$ to $+71^\circ C$. (Test Methods, C,D).

Preamplifier Spectral Noise Voltage Density

The detector shall be in the dark, at a bias voltage of
130 V_{DRB} - 100. At a center frequency of 1.0 MHz and appropriate quality factor $Q > 100$, the spectral noise voltage density (V_{np}) shall be determined according to the relation

$$V_{out} = V_{np} \sqrt{\Delta f}$$

where V_{out} is the rms voltage appearing at the module output and Δf is the noise equivalent bandwidth. The value of V_{np} is recorded in the data log column E. (Test Method E).

Spectral Noise Voltage Density

The detector shall be in the dark at a reverse bias voltage V_{DR}. At center frequencies of 1, 16, 32 and 48 MHz and bandwidth Δf = 10 KHz or less, the spectral noise voltage density V_n shall be calculated according to the relation

$$V_{out} = V_n \sqrt{\Delta f}$$

The maximum values of V_n shall be as follows:

$25^{\circ}C$	1MHz	5.0×10^{-8} V/Hz$^{1/2}$
	16,32, 48 MHz	1.0×10^{-7} V/Hz$^{1/2}$
$-50,+71^{\circ}C$	1MHz	1.4×10^{-7} V/Hz$^{1/2}$

and V_n shall be recorded in the data log column F. (Test Method F).

Preamplifier Output Impedance

The module responsivity (R) shall be measured as in test method G. Maintaining the same power level (P_{opt}) and bias voltage, the 50 ohm load will be replaced by a load greater than 1MΩ and a new value of V_{out} obtained.

The output impedance is obtained from the relation

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$$Z_0 = \frac{50\ V_{out}}{RP_{opt}}$$

and recorded in the data log column H. (Test Method H). The value of Z_0 shall be less than 50 ohms.

Output Swing

A Gallium Indium Arsenide LED ($\lambda = 1060 \pm 5$ nm) modulated with a 50 ns pulse width and a repetition rate of 1MHz or less, shall be used for this measurement. The power of the radiation from the modulated source shall be controlled by varying the drive current. The LED illumination falling on the module detector shall be increased until the module output voltage is limited by pulse clipping. The output voltage at which pulse clipping begins will be defined as the upper limit of the output swing (V_s).

The value of V_S will be recorded in the data log column K and shall be greater than 1 volt. (Test Method K).

Module Bandwidth

Module Bandwidth shall be inferred from the illuminated noise voltage spectral density. The module shall be reverse biased at V_{DR}. An unmodulated source of illumination of arbitrary spectral distribution will be incident on the module, of intensity such that the photodiode photocurrent is 10μADC. The module output will be connected to a spectrum analyzer whose output is monitored on an x-y recorder, displaying noise voltage density versus center frequency in normalised units. The effective bandwidth will be 10 KHz over the frequency range 100 KHz to 70 MHz. From the recorded trace, determination of the frequency (BW) at which the noise voltage is 3db below its value at 100 KHz, yields the module bandwidth directly. The bandwidth shall be greater than 20 MHz.

(3)

A similar trace will be recorded for the detector in the dark and both traces recorded in the data log (Figure 4), (Test Method M).

Risetime and Falltime

The module shall be reverse biased at V_{DR} and illuminated by radiation from a Gallium Indium Arsenide LED ($\lambda = 1060 \pm 5$ nn). The LED shall have a rise and fall time less than 5 ns, and shall be operated with a minimum pulse width of 50 ns. The depth of modulation of the LED shall be varied so that the varying component of the module output has a 250 mV amplitude suitable for oscilloscope presentation. The rise time will be the time elapsed between 25 mV and 225 mV amplitude on the pulse leading edge and the fall time the time between 225 mV and 25 mV amplitude of the trailing edge. The rise and fall times will be recorded in the data log, columns I and J, and shall not exceed 18 ns, throughout the temperature range $-50^{\circ}C$ to $+71^{\circ}C$. (Test Method I,J).

Recovery Time

At room temperature, the module shall be reverse biased so that the responsivity is equal to 2.7×10^5 v/w, at λ = 1060 nm. The module will then be illuminated by a pulsed optical laser. It is the intention to use a 1060 $\pm$ 5nn laser for this measurement. If the existing state of the art availability of solid state lasers is inadequate, a 900 $\pm$ 20 nn laser may be substituted. The modulation and intensity of the source will be varied so as to provide pulses of maximum width 5ns, and minimum power equivalent to 0.5w at 1060 nm. A reference photodiode may be used to establish this equivalent power.

The module output will be displayed on an oscilloscope. The recovery time will be the elapsed time between the 100 mV points of the leading and trailing edges, and shall not exceed 660 ns. The recovery time will be recorded in the data log (Test Method N).

TERMS AND SYMBOLS

V_{DR}	-	Diode reverse voltage
V_{OO}	-	Output offset voltage
I^+	-	Positive DC supply current
I^-	-	Negative DC supply current
HV_I	-	High voltage supply current
V_n	-	Spectral output noise voltage density
R	-	Responsivity (volts/watt)
Z_o	-	Preamplifier output impedance
t_r	-	Risetime
t_f	-	Falltime
V_{out}	-	Output voltage
V/W	-	Volts/watt
V_{DRB}	-	Diode reverse voltage breakdown

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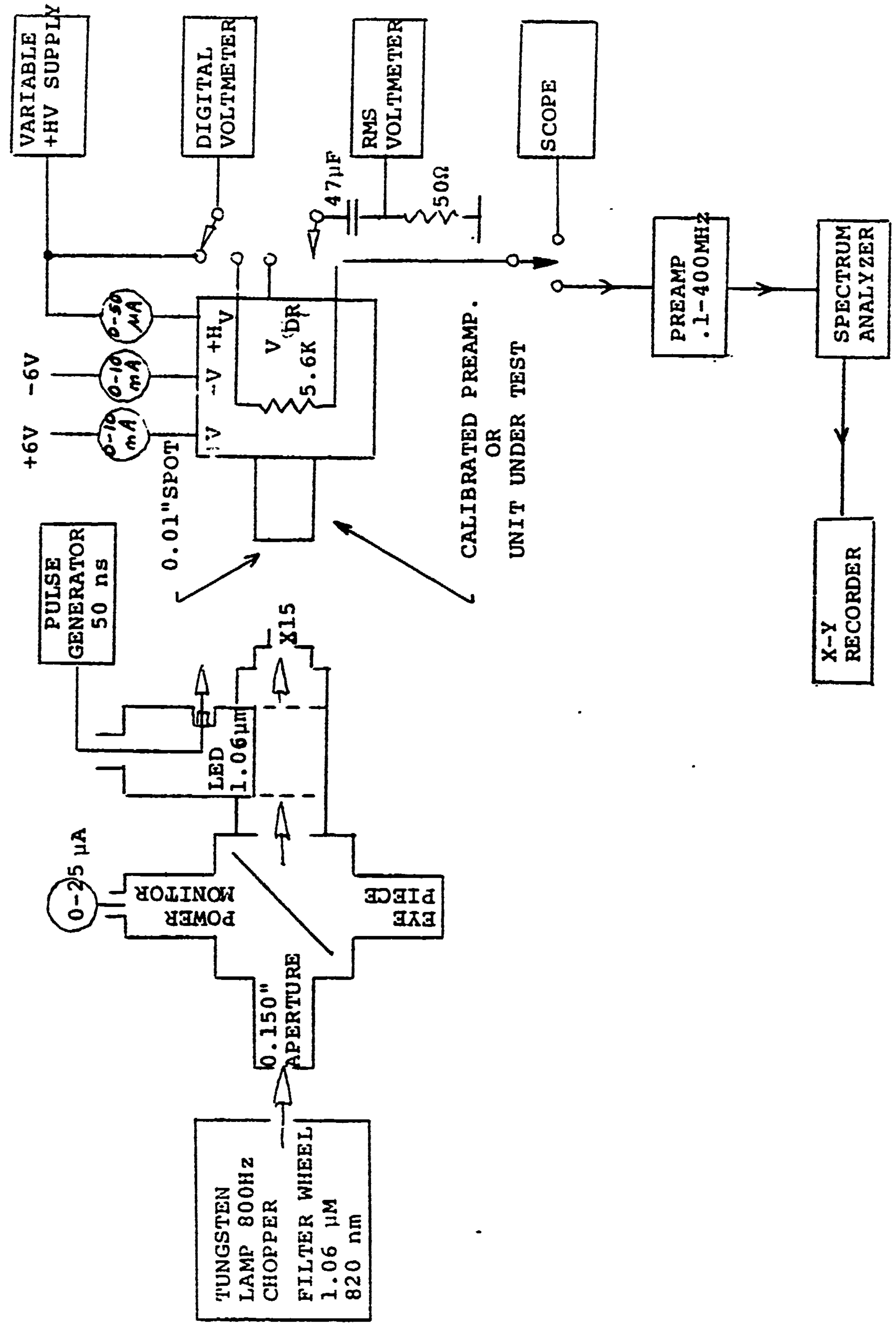

A SIZE

FIGURE 1

REV.

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FIGURE 2

DATE __________ SERIAL NO. __________

TEST SEQUENCE __________ TESTED BY __________

TEST	A	B	C	D	E	F	G	H	I	J	K
SYMBOL	V_{DRB}	V_{oo}	I^+	I^-	V_n	V_n	V_{DR}	Z_o	t_r	t_f	V_{out}
TEST CONDITIONS	$P_D = 0$						$\lambda = 1.06\mu m$				
	10 µA	$V_{DR} = V_{DRB} - 100$				NOTE 1			$V_{DR} - V_{DRB} - 100$		
					FREQ = 10.0MHz ΔF = 10 KHz				PULSE WIDTH = 50ns		
MAX		-0.3	4.0mA	4.0mA	5.0µV	5.0µV		50Ω	18ns	18 ns	
MIN	.	01.3			-	-		-	-	-	1.0V
TEMP +22°C$\pm$ 5 TEST I											
+22°C$\pm$5 TEST II											
+71°C$\pm$5 TEST III						NOTE 2					
-50°C$\pm$5 TEST IV											

NOTE 1 TEST I R = 3.4×10^5 V/W
TEST II R = 3.4×10^5 V/W
TEST IIIR = 2.7×10^5 V/W
TEST IV R = 2.7×10^5 V/W

NOTE 2 V_n max = 14.0 µV at +71°C

TEST N t_{rev}

MAX 660 ns

MEASURED __________

A SIZE | CODE IDENT NO. 95311 | SHEET | CONT'D ON SH | REV.

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TEST SOCKET

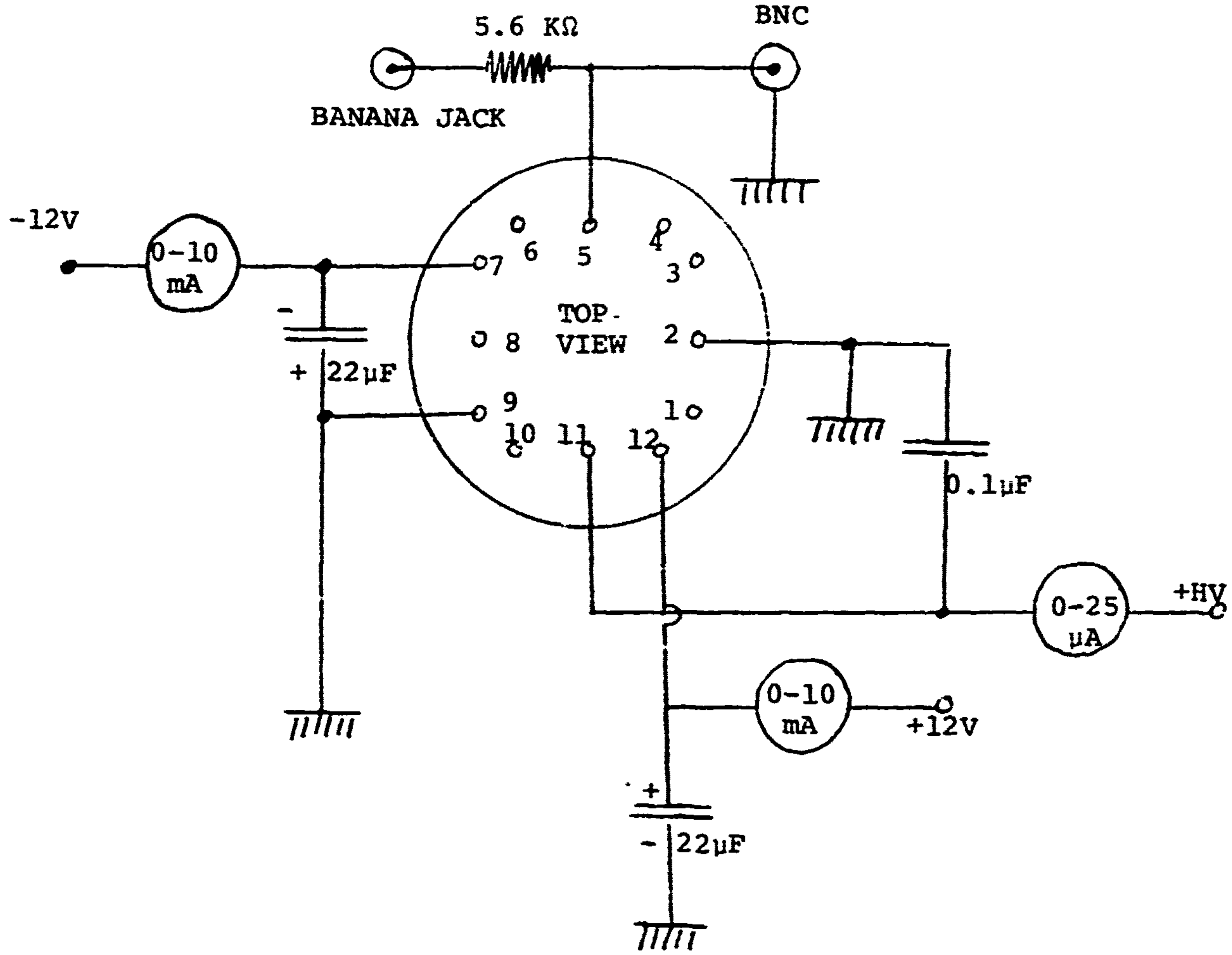

FIGURE 3

A SIZE
CODE IDENT NO. 95311 SHEET CONT'D ON SH
REV.
-6-1/71

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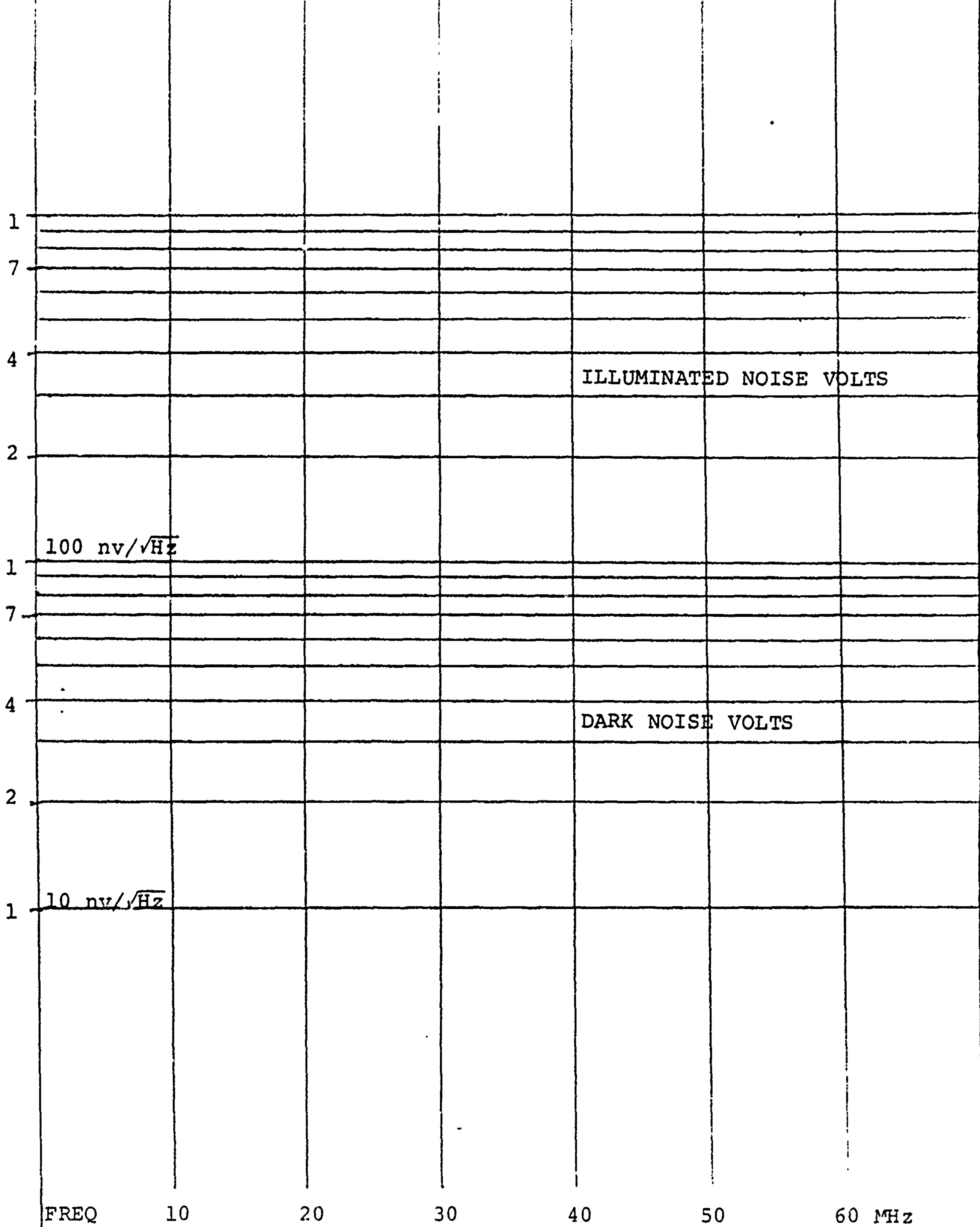
FIGURE 4



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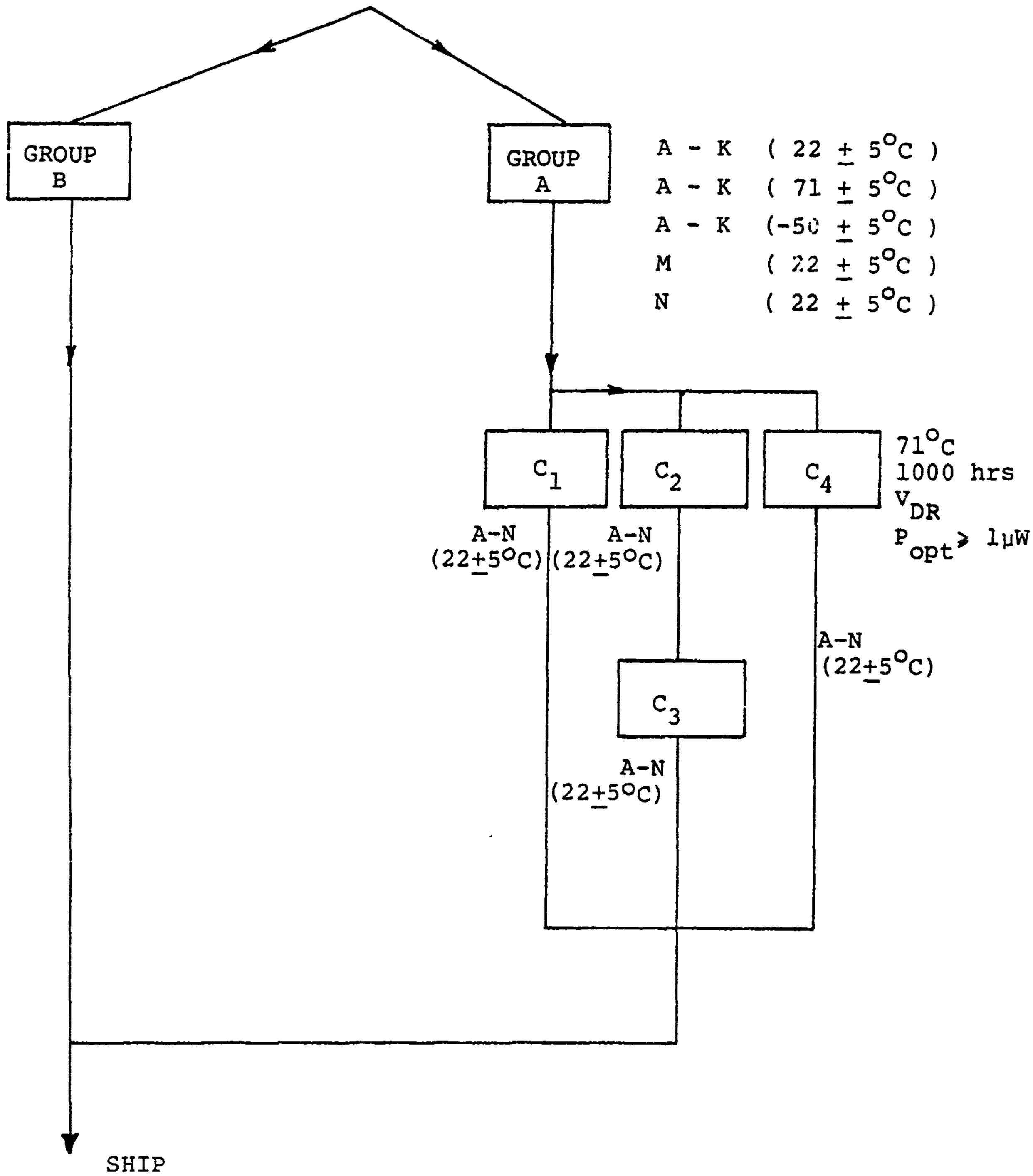
8.1.8.4. Test Sequence



SECTION 2

GROUP 'B' TESTING

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TEST	REQT PARA	MIL-STD 883 METHOD & CONDITION	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
GROUP 'B' SUBGROUP 1 A. Physical Dimensions	3.3.2	2009	Inspect and measure case outline	Microscope Tesa Vernier calipers	N/A
B. Window	3.8		No AR coating req'd on rangefinder		
SUBGROUP 2 A. Resistance to Solvents	3.9	2015	Immerse units for 1 min in solution. Remove then brush for 10 strokes normal hand pressure. Repeat above for total of 4 immersions. Examine units for any evidence of deterioration.	Toothbrushes Glass beakers Solutions of 1. Methyl Alcohol 2. Ethyl Alcohol 3. Isopropyl Alcohol 4. Isopropyl Alcohol + water. Microscope.	N/A N/A N/A
B. Internal visual and mechanical	3.3	2014	Examine units under microscope.	A/O microscope	N/A
C. Bond strength	3.10	2011 Cond. 'D'	All bond pulls shall be counted and the specified sampling, acceptance and added sample provisions shall be observed.	Engineered technical products - Micro Bond tester model MBT-a	
SUBGROUP 3 Solderability	3.11	2003	Immerse leads into molten solder then solder dip leads temperature of solder $260 \pm 10^{o}C$. Examination of leads after cleaning under microscope.	EISCO solder pot type 75T A/O microscope	N/A N/A

A SIZE | CODE IDENT NO 95311 | SHEET | CONT'D ON SH | REV.

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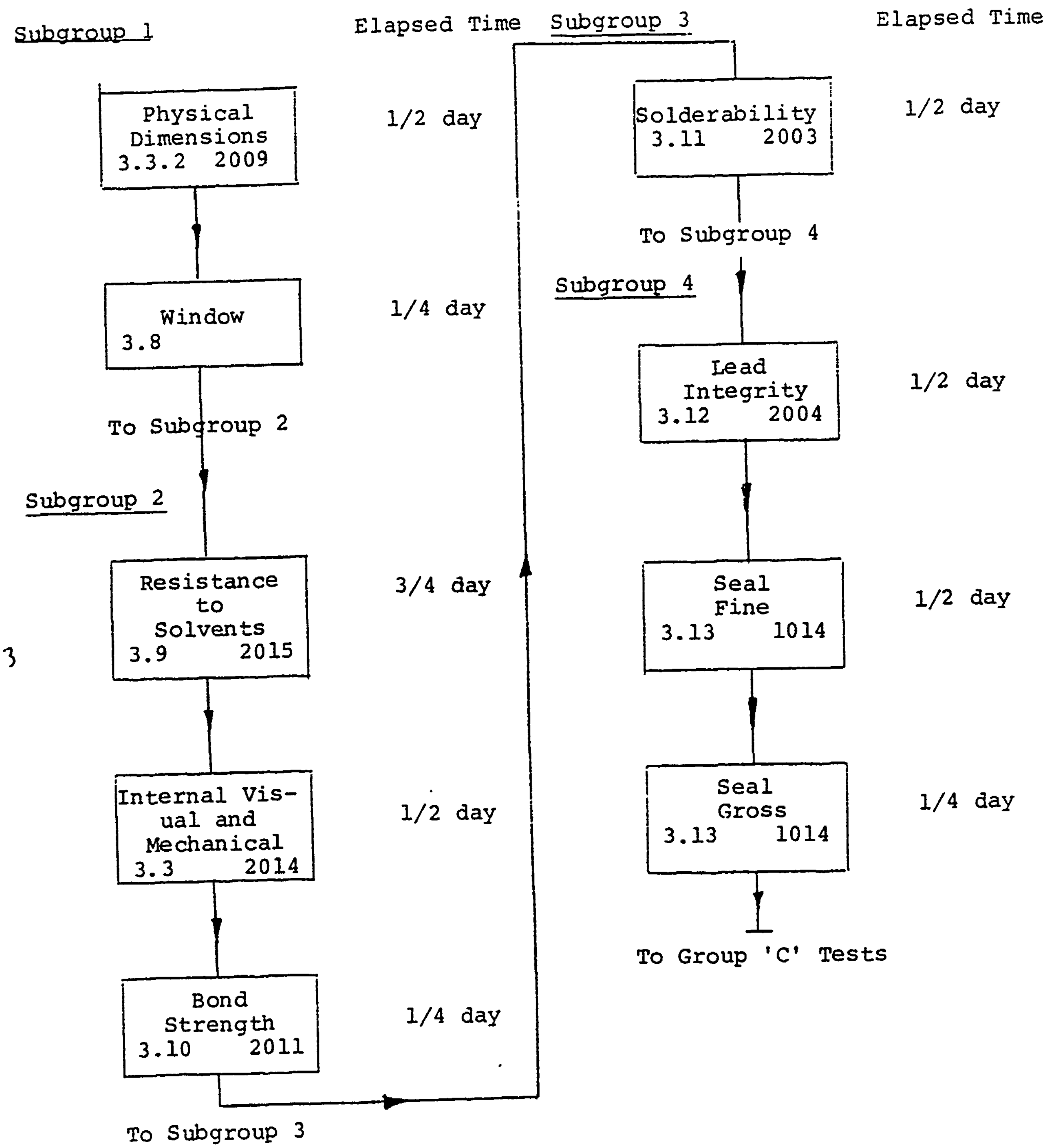
GROUP B

TEST	REQT PARA	MIL-STD 883 Meth. & CONDITION	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
SUBGROUP 4 Lead Integrity	3.12	2004 Cond. B_2.	Apply force of .229$\pm$.014 Kg to each lead to be tested for three 90$\pm$5 degrees arcs of the case.	Attaching devices, clamps, and supports.	
Seal (a) Fine	3.13	1014 Cond. A_1	Prebomb units with 60 lbs He for 4 hrs. in pressure chamber fine leak units on Veeco leak detector.	Pressure chamber Veeco leak tester Model MS90	N/A N/A
(b) Gross	3.13	1014 Cond. C_1.	Units immersed in flourinert bath at 120°C for 30 sec. unless bubbles occur earlier.	Trio Tech Model 481 F	N/A

A SIZE | CODE IDENT NO. 95311 | SHEET | CONT'D ON SH | REV.

GROUP B



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NOTE: Electrical reject devices from same inspection lot may be used for all subgroups.

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SECTION 3

GROUP 'C' TESTING

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GROUP C

TEST	REQT PARA	MIL-STD 883 Meth. & CONDITION	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
SUBGROUP 1 Thermal Shock	3.14	1011 Cond. A	Devices are alternately immersed into beaker of boiling water for 5 min then transferred to liquid of other temperature extreme for 5 min. Above to take 15 cycles at each temperature extreme.	Thermometers Suitable containers Hot plate.	N/A N/A
Temperature Cycling	3.15	1010 Cond. A	Units placed in a temperature chamber and subjected to 10 cycles from -55°C to 85°C at 10 min at each extreme	Temperature chamber Delta design [illegible] 3900 H.P. Recorder /155B H.P. Thermometer 2802A	24 Jan 78 24 Jan 78
Moisture Resistance	3.3.4 3.21	1004	Units are subjected to a specified humidity and temperature cycling in specially designed temperature-humidity chamber.	This test is performed at the Cdn Government Quality Engineering Test Establishment (QETE) at Hull, Que.	
Seal (a) Fine	3.13	1014 Cond. A_1	Prebomb units with 60 lb He for 4 hrs in specially designed pressure chamber. Fine leak test on Veeco Leak Detector.	Pressure Chamber Veeco Leak Tester Model MS90	N/A N/A
(b) Gross	3.13	1014 Cond. C_1	Units immersed in flourinent bath at 120°C for 30 sec unless bubbles occur earlier.	Trio Tech Model 481F	N/A

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GROUP C

TEST	REQT PARA	MIL-STD 883 Meth & Condition	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
Visual Examination	3.3	2009.1	Examination of units under microscope for any defects	A/O microscope	N/A
End point electrical parameters			Electrical tests done as per subgroups 1, 4, and 7 of Table III.		
SUBGROUP 2 Mechanical shock	3.16	2002 Cond. 'B'	Units mounted on specially designed shock plate. Devices subjected to two shocks in each of the 6 axis of 1500 G for 0.5 ms each.	This test is performed at the Canadian Government Quality Engineering Test Establishment (QETE) at Hull, Que.	unknown
Vibration variable frequency	3.17	2007 Cond. 'A'	Upon completion of the mechanical shock the units on the same plate are transferred to the vibration table and are subjected to a vibration with a peak acceleration of 20 g with a frequency range of 20 to 2000 Hz.	As above.	unknown
Constant acceleration	3.18	2001 Cond. 'A'	Devices are restrained by normal mounting procedures and acceleration is applied of 5000 g for 1 minute in each of the 6 axis.	International Centrifuge size 2 Model K I.C. Tachometer No. 748	4 NOV. 77
Seal (a) Fine	3.13	1014 Cond. A_1.	Units are prebombed with 60 lbs He for 4 hrs in a pressure chamber. Fine leak done	Pressure chamber Veeco Leak Tester Model MS90	N/A N/A

TEST	REQT PARA	MIL-STD 883 Meth & CONDITION	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
			on a Veeco leak detector.		
Seal (b) Gross	3.13	1014 C_1	Units immersed in fluorinent bath at 120°C for 30 sec unless bubbles occur earlier.	Trio Tech Model 481F	N/A
Visual Examination	3.3		Examine units under microscope for defects or damage to leads, seals or case.	A/O Microscope 7X to 40X	N/A
End Point Electrical parameters			Subgroups 1,4,7 of Table III.		
<u>SUBGROUP 3</u> High Temperature Storage	3.19	1008	Units placed in oven at 85°C for 24 hours	Thelco Oven Thermometer	N/A
End Point Electrical Parameters			Subgroups 1,4,7 of Table III.		
<u>SUBGROUP 4</u> Operating Life	3.20	1005 Cond. 'B'	Modules biased per subgroups 1,2,4,7 and 8 per Table III with P_{opt} of 1 μw min temp. 71°C		
End Point Electrical Parameters			Per Subgroups 1,4, & 7 of Table III.		

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GROUP C

Subgroup 1	Elapsed Time	Subgroup 2	Elapsed Time
Thermal Shock 3.14 1011	1/2 day	Mechanical Shock 3.16 2002	Done at QETE 1/2 day
Temperature Cycling 3.15 1010	1 day	Vibration Variable Frequen. 3.17 2007	Done at QETE 1/2 day
	Send to QETE		
Moisture Resistance 3.3.4 1004	10 + 4 days	Constant Acceleration 3.18 2001	Returned to RCA 1 day 1/2 day
	Return to RCA		
Seal Fine 3.13 1014	1/2 day	Seal Fine 3.13 1014	1/2 day
Seal Gross 3.13 1014	1/4 day	Seal Gross 3.13 1014	1/4 day
Visual Examination 3.3	1/4 day	Visual Examination 3.3	1/4 day
End Point Electrical Parameters	1/2 day	End Point Electrical Parameters	1/2 day
	Send to QETE 1 day		To Subgroup 3

GROUP C TESTS

Subgroup 3

Test	Duration
High Temperature Storage 3.19 1008	1 day
End Point Electrical Parameters	1/2 day

To subgroup 4

Subgroup 4

Test	Duration
Operating life 3.20 1005	43 days
End Point Electrical Parameters	1 day

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SECTION 4

COMPOSITE FLOW DIAGRAM

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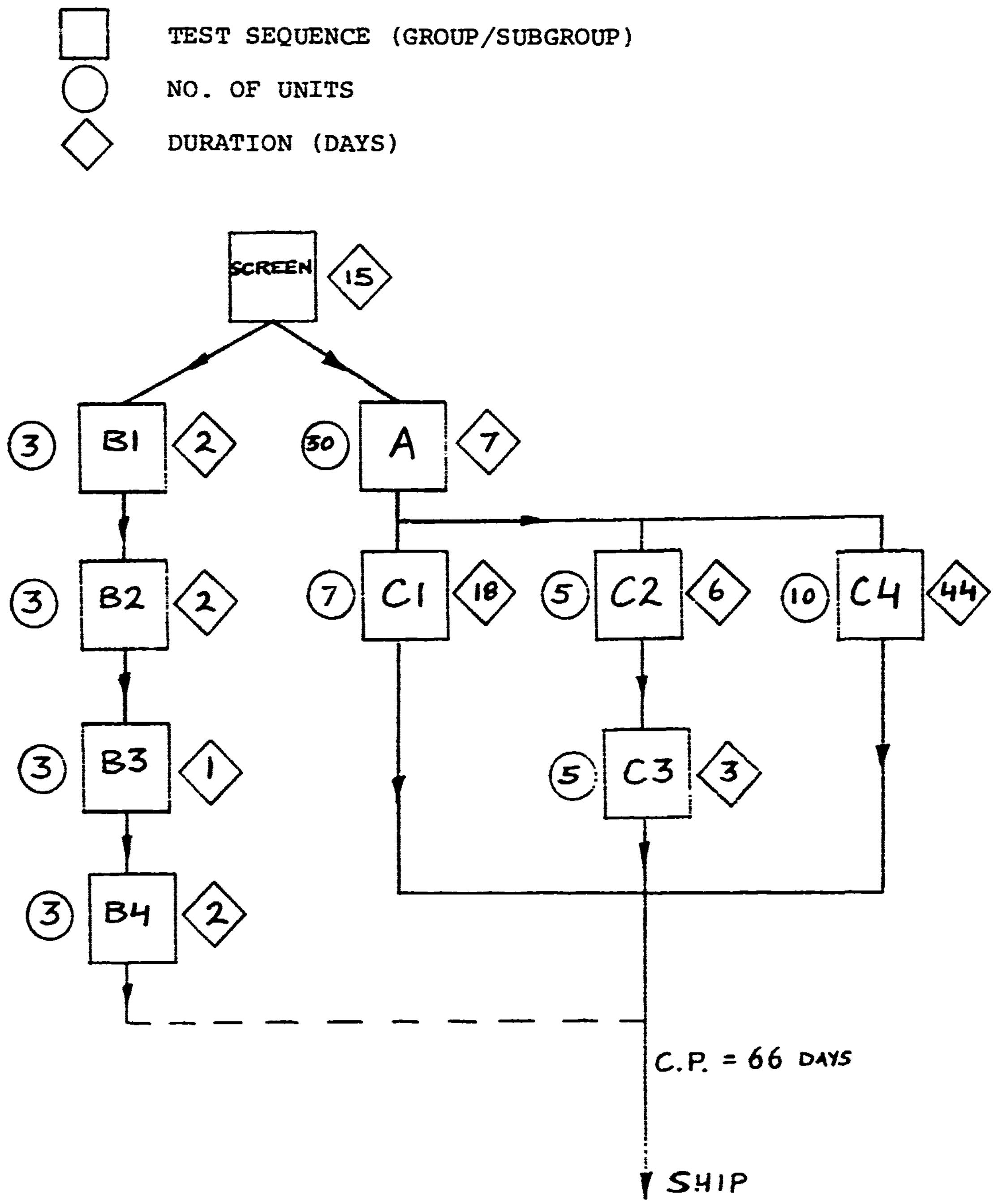
6. COMPOSITE FLOW DIAGRAM FOR SAPDM-1 (MMT-769776-2) and SAPDM-2 (MMT-769776-3)

FINAL TEST BLOCK SUMMARY



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PRODUCT ASSURANCE TEST DEMONSTRATION AND EVALUATION PLAN

SAPDM-2

SECTION 1

GROUP 'A' TESTING

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1.2.1 Specification for LED Source

LED - RCA TYPE C30123 ($\lambda = 820$ nm)
DRIVER - HP8015A Pulse Generator

1.2.2 Specification for reference power monitor

PIN PHOTODIODE/HYBRID PREAMPLIFIER-FET INPUT C30847

Responsivity - 7.0×10^5 v/w min at $\lambda = 820 \pm 10$ nm
NEP - 5×10^{-13} W/Hz$^{\frac{1}{2}}$ MAX at $\lambda = 820 \pm 10$ nm
RESPONSE TIME - 3×10^{-6} s max.

The power monitor is calibrated for responsivity by reference to a standard detector of spectral response established by an independent laboratory.

1.2.3 Specification for Optical System

LIGHT SOURCE - EALING OPTIMOD 28-8449
CHOPPER - BULOVA TUNING FORK 800 Hz
OPTICS - EALING REFLECTING OBJECTIVE X15, - 250506
FILTERS - BANDPASS FWHM 100Å

The control of incident radiation power is achieved by adjustment of separation between source and entrance pupil of the optical system.

RCA Electro Optics and Devices

Infrared Emitters

Developmental Types

C30119, C30123

High-Speed Aluminum Gallium Arsenide IR-Emitters for Continuous or Pulse Applications

- **Typical Rise Time:**
  C30119 – 3 ns
  C30123 – 8 ns
- **Typical Frequency Response**
  C30119 – 150 MHz
  C30123 – 50 MHz

RCA Developmental Types C30119 and C30123 are high-speed aluminum gallium arsenide infrared emitting diodes designed especially for use in fiber-optically coupled communication systems using either single fibers or bundles. These devices are supplied in an OP-18 package having a removable cap. The differences between the devices are shown under **Characteristics**.

Both the C30119 and C30123 are edge emitting devices having a small source size which enhances their use with available fiber-optic materials.

Variants of these emitters are available with hermetically-sealed packages upon request.

Maximum Ratings, Absolute-Maximum Values

Continuous Operation		
Forward Current, I_F:		
At case temperatures up to +30° C	200	mA
At case temperatures above +30° C	See Figure 7	
Peak Reverse Voltage, V_{RM}	2.0	V
Pulse Operation		
Peak Forward Current, I_{FM}:		
At t_w = 100 ns, du = 5%	1.5	A
Temperature:		
Storage, T_{stg}	−40 to +120	°C
Operating, case, T_C	−40 to +90	°C
Soldering:		
For 5 seconds	200	°C

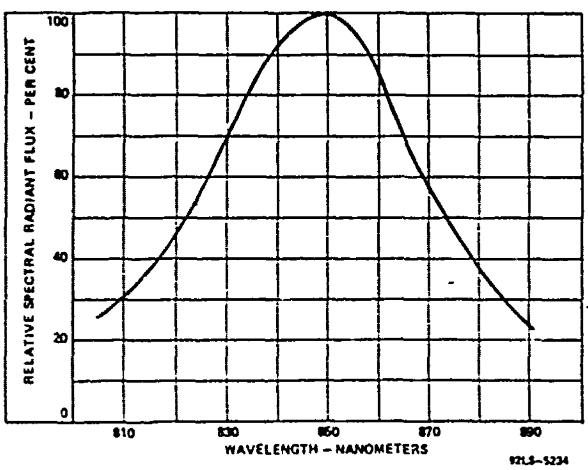

Figure 1 – Typical Spectral Radiant Flux for Type C30119

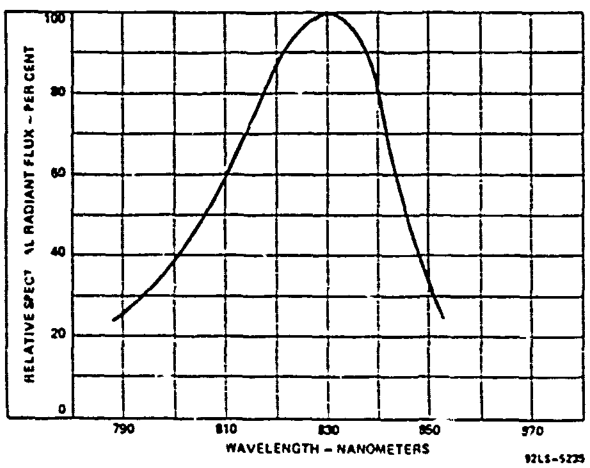

Figure 2 – Typical Spectral Radiant Flux for Type C30123

For further information or application assistance on these devices, contact your RCA Sales Representative or write Solid State Electro Optics Marketing, RCA, Lancaster, PA 17604

Printed in U.S.A. 5-77

Characteristics at T_C = 27° C	Type C30119			Type C30123			Units
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Continuous Operation							
Radiant Flux, Φ, (Power Output)							
At I_F = 200 mA	300	500	–	800	1000	–	μW
Forward Voltage Drop, V_F	–	1.5	2.5	–	2	3	V
Pulse Operation							
Total Peak Radiant Flux, Φ_M, (Peak Power Output) at I_F = 1 A:							
At t_W = 50 ns, du = 5%	–	5	–	–	7.5	–	mW
Peak Forward Voltage Drop, V_{FM}	–	3	–	–	5	–	V
Switching Characteristics							
Rise Time of Emitted Pulse, t_r (10% to 90%)	–	3	–	–	8	–	ns
Frequency Response							
Bandwidth (3 dB Point)							
At I_F = 100 mA, I_{AC} = 80 mA	100	150	–	40	50	–	MHz
Beam Characteristics							
For Continuous or Pulse Operation							
Wavelength of Peak Radiant Intensity	830	850	870	810	830	850	nm
Spectral Line Width Between Half Intensity Points	–	50	–	–	40	–	nm
Mechanical							
Source Size	–	1x6	–	–	1x6	–	mils

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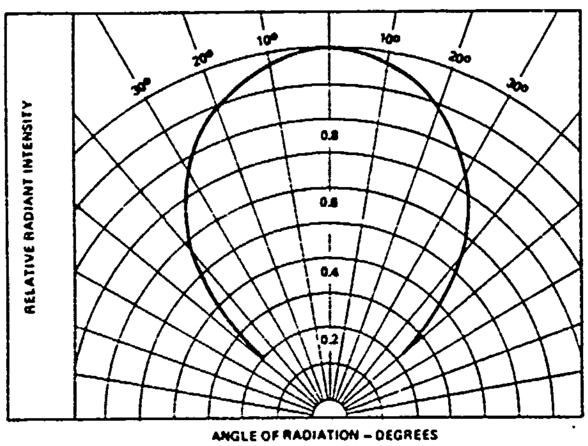


Figure 3 – Typical Radiant Intensity Pattern in the Plane Parallel to the Junction

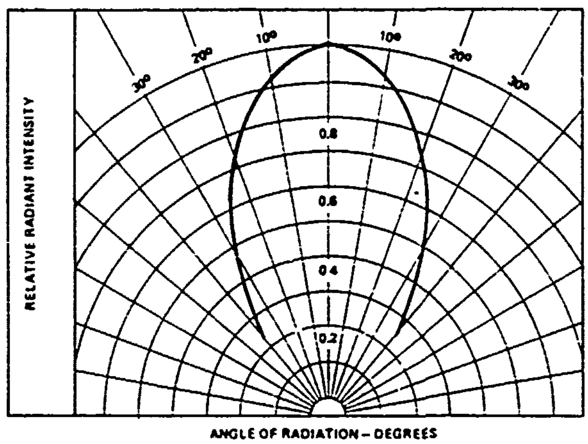


Figure 4 – Typical Radiant Intensity Pattern in the Plane Perpendicular to the Plane of the Junction

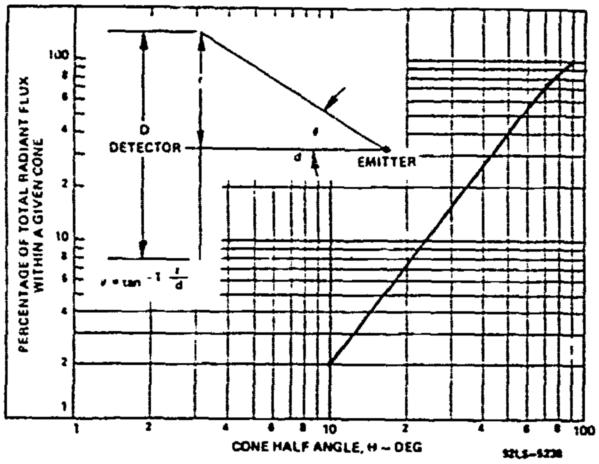


Figure 5 — Percentage of Total Radiant Flux Within a Given Cone Angle

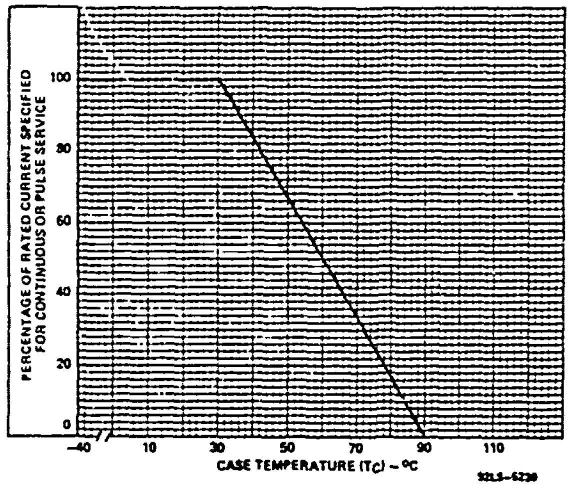


Figure 7 — Current Derating Curve

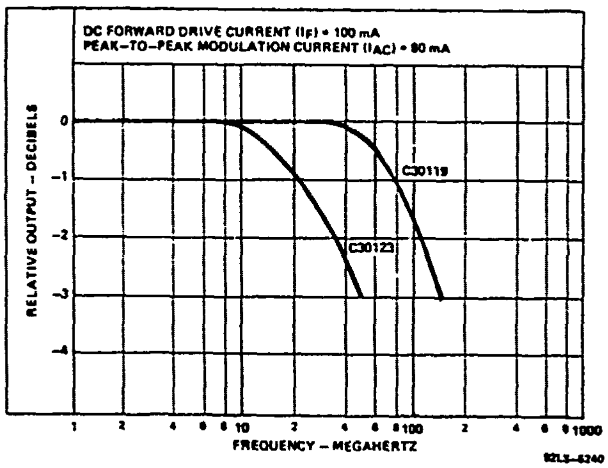
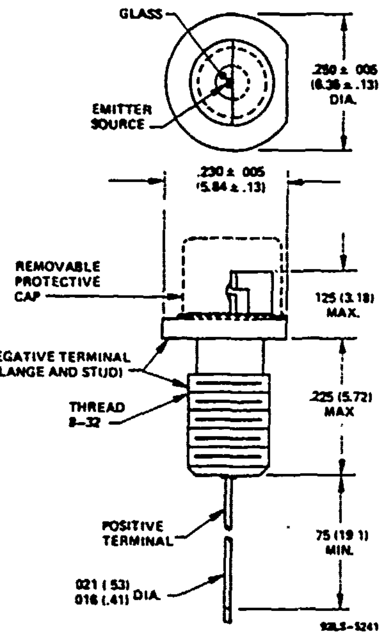


Figure 6 — Typical Frequency Response Characteristics



Dimensions in parentheses are in millimeters.

Figure 8 — Dimensional Outline

1.3 Description of Test Methods

Responsivity

The module shall be illuminated with a source of wavelength 820 $\pm$ 5nm, obtained by filtering of a tungsten filament source. The radiation shall be chopped at a frequency of 800 Hz. (The power incident on the detector (P_{opt}) shall be measured using a standard reference detector). The bias voltage on the module is increased until the responsivity, defined as the ratio of the rms output voltage (V_{out}) to P_{opt} attains the required value. The output of the module shall be A.C. coupled to a 50 ohm load for this measurement. The bias voltage (V_{DR}) is recorded in the data log column A. The required value of responsivity will exceed 1.3 x 10^6 v/w over the temperature range -50^oC to $+71^oC$ and will be recorded in column G of the data log. (Test Method C).

Output Offset Voltage

With the detector in the dark, the reverse bias voltage is set to V_{DR}. The voltage appearing at the module output is the preamplifier output offset voltage (V_{oo}). This is recorded in the data log column B. (Test Method B).

Power Consumption

With the detector in the dark, the high voltage is set to +550 VDC, and the photodiode reverse bias to V_{DR}. With $\pm V_{cc} = \pm$ 6.0 volts, the currents flowing through the $+ V_{cc}$ and $- V_{cc}$ rails shall be measured and designated I^+ and I^- respectively. These currents are recorded in the data log columns C and D. The current I flowing in the high voltage rail will be measured and recorded in column E. The value of P_{in}, defined as

$$6\ (I^{+} + I^{-}) + 550\ I = P_{in}$$

shall not exceed 100 mW, over the temperature range of $-50^{o}C$ to $+71^{o}C$. (Test Method A).

Spectral Noise Voltage Density

The detector shall be in the dark at a reverse bias voltage V_{DR}. At center frequencies of 1, 16, 32 and 48 MHz and bandwidth Δf = 10 KHz or less the spectral noise voltage density V_n shall be calculated according to the relation

$$V_{out} = V_n \sqrt{\Delta f}$$

The maximum values of V_n shall be as follows:

$25^{o}C$	1MHz	5.0×10^{-8} v/Hz$^{\frac{1}{2}}$
58	16, 32, 48 MHz	1.0×10^{-7} v/Hz$^{\frac{1}{2}}$
$-50, +71^{o}C$	1MHz	1.4×10^{-7} v/Hz$^{\frac{1}{2}}$

and V_n shall be recorded in the data log column F. (Test Method D).

Preamplifier Output Impedance

The module responsivity (R) shall be measured as in test method C. Maintaining the same power level (P_{opt}) and bias voltage, the 50 ohm load will be replaced by a load greater than 1 MΩ, and a new value of V_{out} obtained. The output impedance of the amplifier if obtained from the relation

$$Z_o = \frac{50\ V_{out}}{RP_{opt}}$$

and recorded in the data log column H. (Test Method E). The value of Z_o shall be less than 50 ohms.

Output Swing

A Gallium Aluminum Arsenide LED ($\lambda = 820 \pm 5$ nm) modulated with a 50 ns pulse width and a repetition rate of 1 MHz or less, shall be used for this measurement. The power of the radiation from the modulated source shall be controlled by varying the drive current. The LED illumination falling on the module detector shall be increased until the module output voltage is limited by pulse clipping. The output voltage at which pulse clipping begins will be defined as the upper limit of the output swing (V_s). The value of V_s will be recorded in the data log column K and shall be greater than 1 volt. (Test Method F).

Module Bandwidth

Module Bandwidth shall be inferred from the illuminated noise voltage spectral density. The module shall be reverse biased at V_{DR}. An unmodulated source of illumination of arbitrary spectral distribution will be incident on the module, of intensity such that the photodiode photocurrent is 10 μADC. The module output will be connected to a spectrum analyzer whose output is monitored on an x-y recorder, displaying noise voltage density versus center frequency in normalised units. The effective bandwidth will be 10 KHz over the frequency range 100 KHz to 70 MHz. From the recorded trace, determination of the frequency (BW) at which the noise voltage is 3db below its value at 100 KHz, yields the module bandwidth directly. The bandwidth shall be greater than 20 MHz.

A similar trace will be recorded for the detector in the dark and both traces recorded in the data log (Figure 4). (Test Method H).

Risetime and Falltime

The module shall be reverse biased at V_{DR} and illuminated by radiation from a Gallium Indium Arsenide LED ($\lambda = 820 \pm 5$ nm). The LED shall have a rise and fall time less than 5 ns, and shall be operated with a minimum pulse width of 100 ns. The depth of modulation of the LED shall be varied so that the varying component of the module output has a 250 mV amplitude suitable for oscilloscope presentation. The rise time will be the time elapsed between 25 mV and 225 mV amplitude on the pulse leading edge and the fall time the time between 225 mV and 25 mV amplitude of the trailing edge. The rise and fall times will be recorded in the data log, columns I and J, and shall not exceed 22 ns, throughout the temperature range -50°C to +71°C. (Test Method G).

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TERMS AND SYMBOLS

V_{DR}	-	Diode reverse voltage
V_{OO}	-	Output offset voltage
I^{+}	-	Positive DC supply current
I^{-}	-	Negative DC supply current
HV_{I}	-	High voltage supply current
V_{n}	-	Spectral output noise voltage density
R	-	Responsivity (volts/watt)
Z_{o}	-	Preamplifier output impedance
t_{r}	-	Risetime
t_{f}	-	Falltime
V_{out}	-	Output offset voltage
V/W	-	Volts/watt
V_{DRB}	-	Diode reverse voltage breakdown

A SIZE

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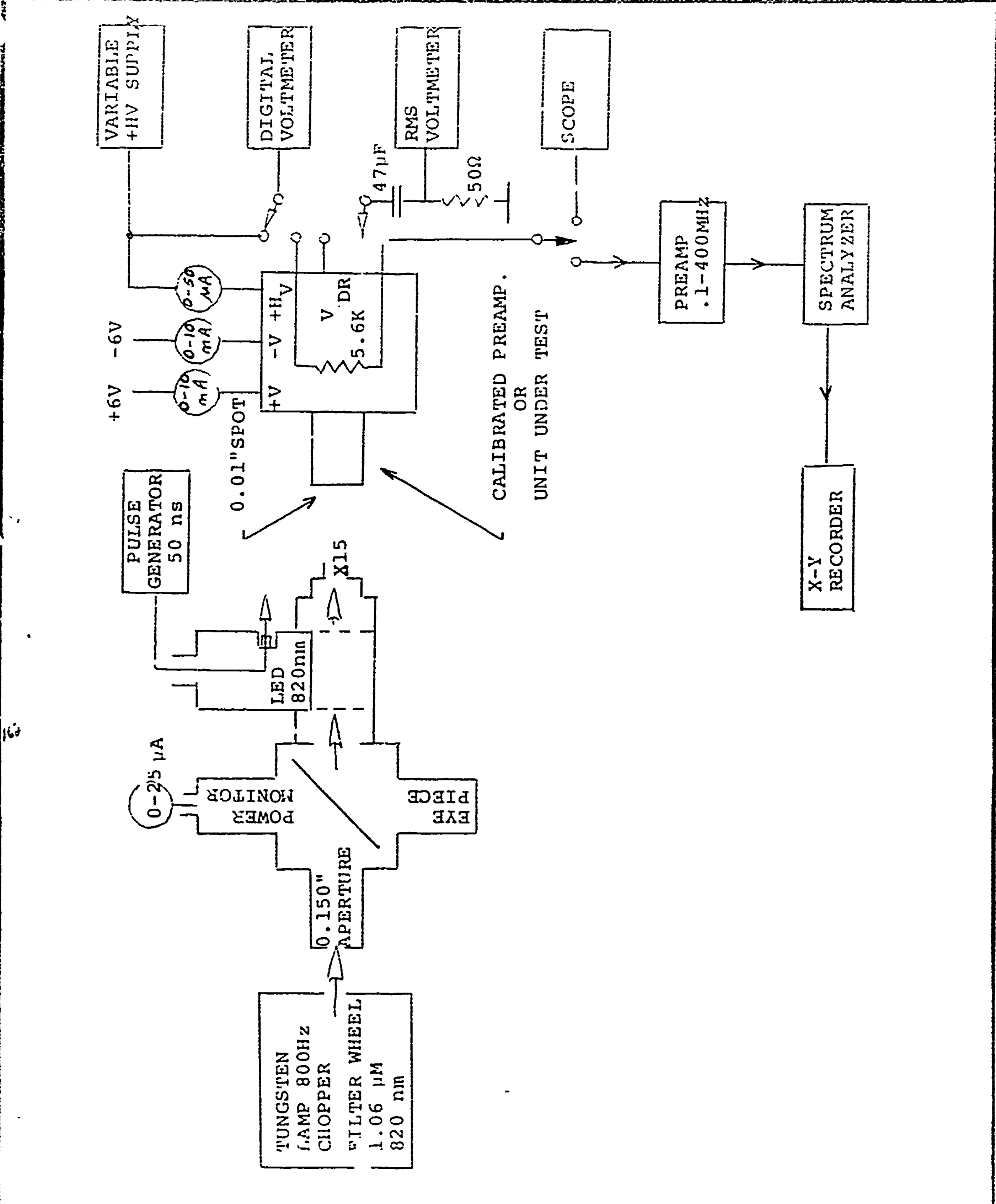

A | FIGURE 1 | REV.

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FIGURE 2

DATE ____________ SERIAL NO. ____________

TEST SEQUENCE ____________ TEST BY ____________

TEST	A	B	C	D	E	F	G	H	I	J	K
SYMBOL	V_{DR}	V_{OO}	I^+	I^-	HV_I	V_n	R	Z_O	t_r	t_f	V_{out}
TEST CONDITIONS	$P_D = 0$						$\lambda = 820$ nm				
	RESPONSIVITY SET TO $\geq 1.3 \times 10^6$ V/W										
						F=1.0MHz ΔF=10 MHz	$R = \frac{O/P\ V}{P_D}$		PULSE WIDTH = 50 ns		
MAX		-0.3	6.0mA	6.0mA	50µA	5.0 µV	-	50Ω	22ns	22ns	1.0V
MIN		-1.3				-	1.3×10^6 V/W	-	-	-	-
TEMP +22°C±5 TEST I											
+22°C±5 TEST II											
+71°C±5 TEST III						NOTE 1					
-50°C±5 TEST IV											

NOTE 1 V_n max = 14.0 µV at 71°C

A

REV.

SAPDM-2 EXTERNAL CONNECTIONS

FIGURE 3

SERIAL #

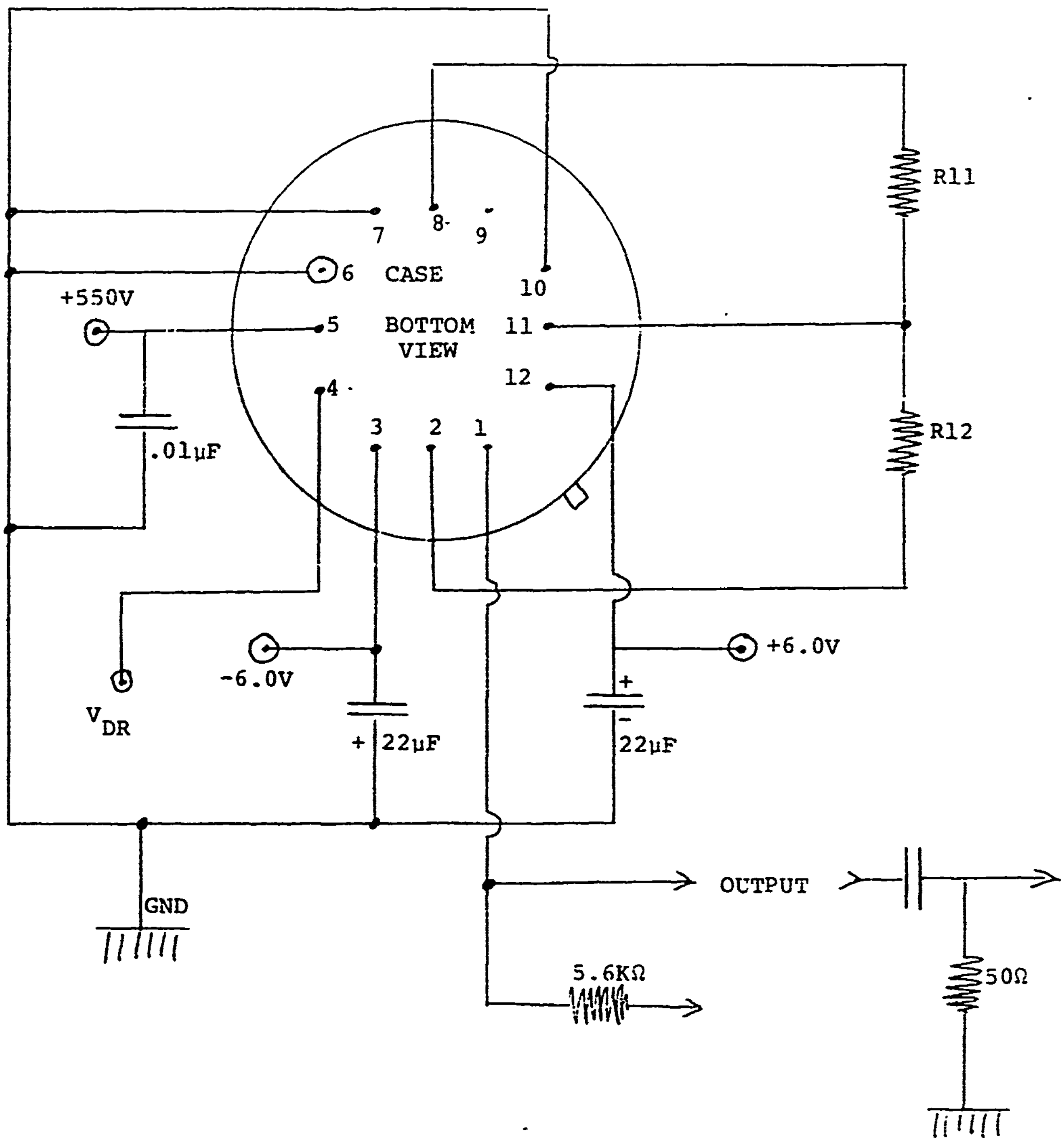
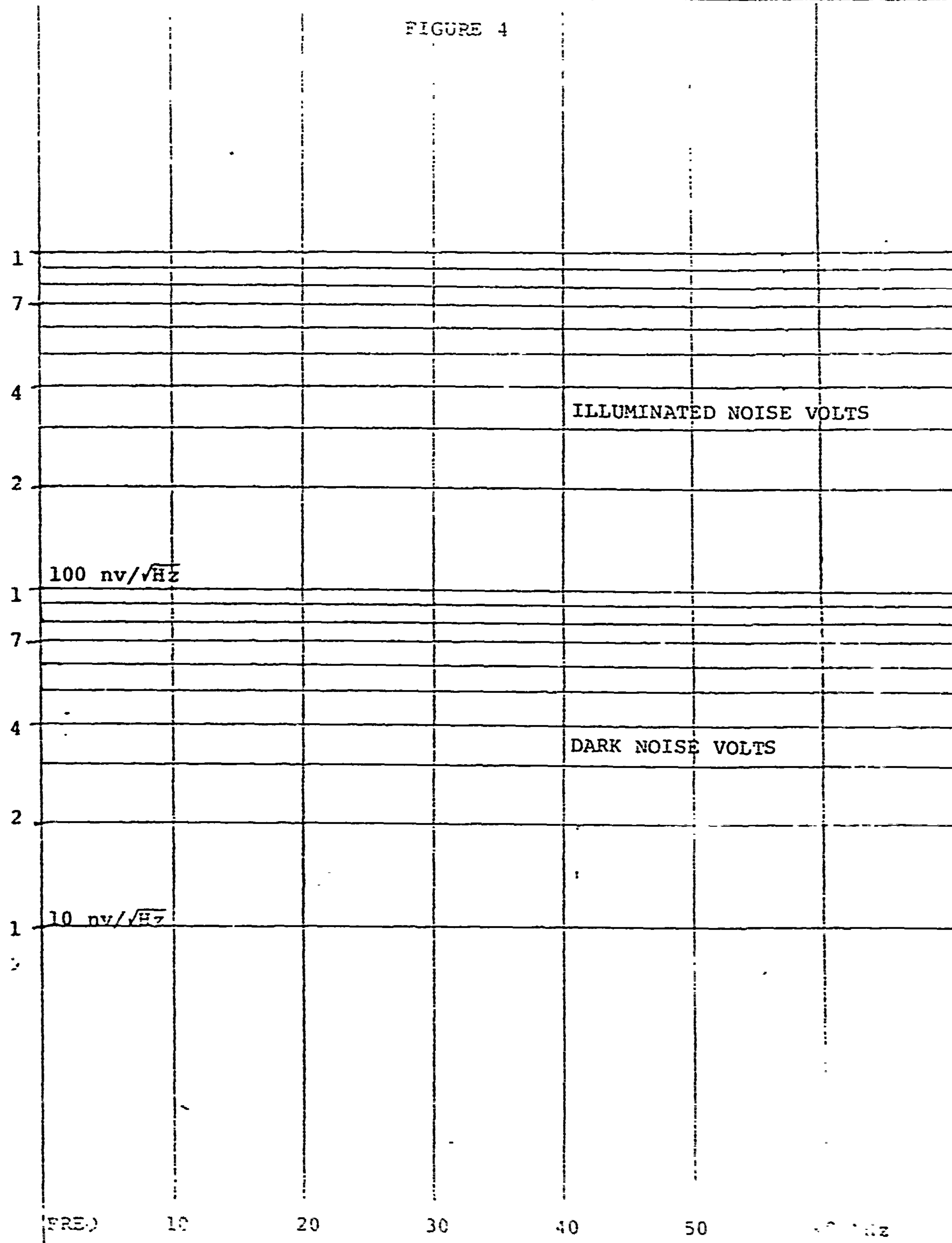
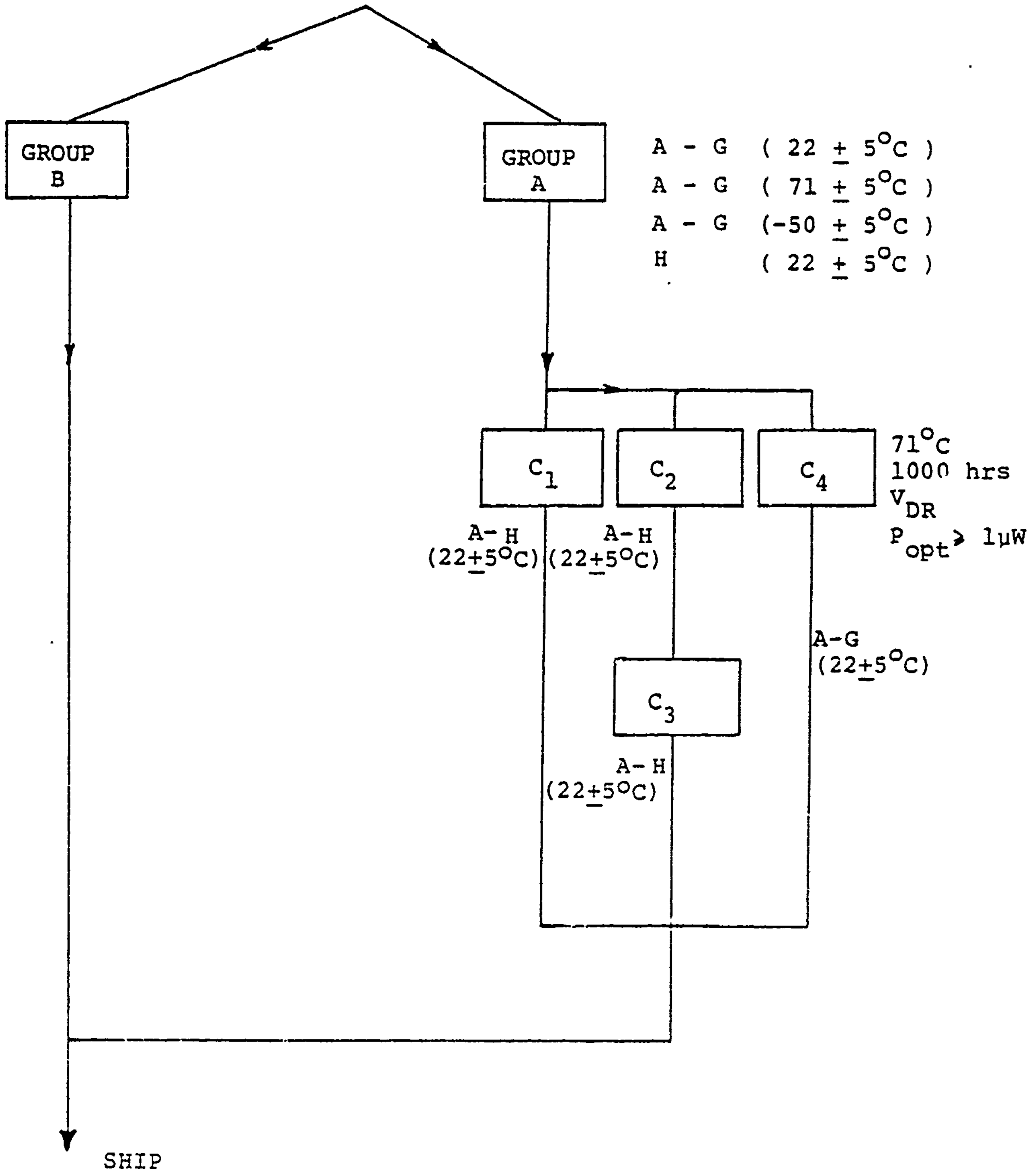


FIGURE 4


1
7
4
ILLUMINATED NOISE VOLTS
2
100 nv/√Hz
1
7
4
DARK NOISE VOLTS
2
10 nv/√Hz
1
FREQ
10
20
30
40
50

1.4 Test Sequence



SECTION 2

GROUP 'B' TESTING

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GROUP B

TEST	REQT PARA	MIL-STD 883 Meth & Condition	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
GROUP B SUBGROUP 1 Physical Dimensions	3.3.2	2009	Inspect and measure case outline	Microscope Tesa Vernier Calipers	N/A
Interchangeability	3.7		a) External resistors to be examined for unit serial number. Mating with specified connector to be verified.		N/A
SUBGROUP 2 Resistance to Solvents	3.9	2015	Immerse units for 1 min in solution. Remove then brush for 10 strokes normal hand pressure. Repeat above for total of 4 immersions. Examine units for any evidence of deterioration	Toothbrushes Glass Beakers Solutions of 1. Methyl Alcohol 2. Ethyl Alcohol 3. Isopropyl Alcohol 4. Isopropyl Alcohol + water Microscope	N/A N/A N/A
Internal Visual and Mechanical	3.3	2014	Examine units under microscope	A/O Microscope	N/A
Bond Strength	3.10	2011 Cond 'D'	All bond pulls shall be counted and the specified sampling, acceptance and added sample provisions shall be observed.	Engineered technical products - micro bond tester Model MBT-a	

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TEST	REQT PARA	MIL-STD 883 Meth & CONDITION	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
SUBGROUP 3 Solderability	3.11	2003	Immerse leads into molten solder then solder-dip leads. Temperature of solder 260 ± 10°C. Examination of leads after cleaning under microscope	EISCO solder pot type 75T A/O Microscope	N/A N/A
SUBGROUP 4 Lead Integrity	3.12	2004 Cond. B_2.	Apply force of .229 ± .014 Kg to each lead to be tested for three 90±5 degrees arcs of the case.	Attaching devices, clamps, and supports	
Seal (a) Fine	3.13	1014 Cond. A_1.	Prebomb units with 60 lbs He for 4 hrs in pressure chamber. fine leak units on Veeco Leak detector	Pressure Chamber Veeco Leak Tester Model MS90	N/A N/A
(b) Gross	3.13	1014 Cond. C_1.	Units immersed in flourinert bath at 120°C for 30 sec unless bubbles occur earlier.	Trio Tech Model 481 F	N/A

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REV.

SAPDM-2

GROUP B

Subgroup 1	Elapsed Time
Physical Dimensions 3.3.2 2009	1/2 day
↓	
Inter-changebility 3.7	1/4 day
↓	
Anti-Reflection Coating 3.8	1/2 day
↓	
Subgroup 2	
Resistance To Solvents 3.9 2015	3/4 day
↓	
Internal Visual and Mechanical 3.3 2014	1/2 day
↓	
Bond Strength 3.10 2011	1/4 day

Subgroup 3	Elapsed Time
Solder-ability 3.11 2003	.1/2 day
To Subgroup 4	
Subgroup 4	
↓	
Lead Integrity 3.12 2004	1/2 day
↓	
Seal Fine 3.13 1014	1/2 day
↓	
Seal Gross 3.13 1014	1/4 day
To Group 'C' Tests	

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NOTE: Electrical reject devices from same inspection lot may be used for all subgroups.

SECTION 3

GROUP 'C' TESTING

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GROUP C

TEST	REQT PARA	MIL-STD 883 Meth & CONDITION	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
SUBGROUP 1 Thermal Shock	3.14	1011 Cond. A	Devices are alternately immersed into beaker of boiling water for 5 min. then transferred to liquid of other temperature extreme for 5 min. Above to take 15 cycles at each temperature extreme	Thermometers Suitable containers hot plate	N/A N/A
Temperature Cycling	3.15	1010 Cond. A	Units placed in a temperature chamber and subjected to 10 cycles from -55°C to 85°C at 10 min at each extreme	Temperature Chamber Delta Design MK3900 H.P. Recorder 7155B H.P. Thermometer 2802A	24 JAN 78 24 JAN 78
Moisture Resistance	3.3.4 3.21	1004	Units are subjected to a specified humidity and temperature cycling in specially designed temperature-humidity chamber.	This test is performed at the Canadian Government Quality Engineering Test Establishment (QETE) at Hull, PQ.	unknown
Seal (a) Fine	3.13	1014 Cond. A_1	Prebomb units with 60 lb He for 4 hrs. in specially designed pressure chamber. Fine leak test on Veeco Leak detector.	Pressure Chamber Veeco Leak Tester Model MS90	N/A N/A
Seal (b) Gross	3.13	1014 Cond. C_1	Units immersed in fluorinert bath at 120°C for 30 sec unless bubbles occur earlier.	Trio Tech Model 481F	N/A

A SIZE

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GROUP C

TEST	REQT PARA	MIL-STD 883 Meth & CONDITION	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
Visual Examination	3.3	2009.1	Examinations of units under microscope for any defect	A/O microscope	N/A
End Point Electrical Parameters			Electrical tests done as per subgroups 1,4, and 7 of Table III.		
SUBGROUP 2 Mechanical Shock	3.16	2002 Cond. B	Units mounted on specially designed shock plate. Devices subjected to two shocks in each of the 6 axis of 1500 G for 0.5 ms each.	This test is performed at the Canadian Government Quality Engineering Test Establishment (QETE) at Hull, PQ	Unknown
Vibration Variable Frequency	3.17	2007 Cond. A	Upon completion of the mechanical shock the units on the same plate are transferred to the vibration table and a vibration with a peak acceleration of 20 g with a frequency range of 20 to 2000 Hz	As above	Unknown
Constant Acceleration	3.18	2001 Cond. A	Devices are restrained by normal mounting procedures and a constant is applied of 5000 g for 1 min in each of the 6 axis	International Centrifuge size 2, Model K I.C. Tachometer No. 748	4 NOV 77

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GROUP C

TEST	REQT PARA.	MIL-STD 883 Meth & CONDITION	DESCRIPTION	MATERIAL OR EQUIPMENT	DATE OF LAST CALIBRATION
Seal (a) Fine	3.13	1014 Cond. A_1	Units are prebombed with 60 lbs He for 4 hrs in a pressure chamber. Fine leak done on a Veeco leak detector.	Pressure Chamber Veeco Leak Tester Model MS90	N/A N/A
Seal (b) Gross	3.13	1014 Cond. C_1	Units are immersed in fluorinert bath at 120°C for 30 sec unless bubbles occur earlier.	Trio Tech Model 481F	N/A
Visual Examination	3.3		Examine units under microscope for defects or damage to leads, seals or case	A/O Microscope 7X to 40X	N/A
End Point Electrical Parameters			Subgroups 1,4,7 of Table III		
SUBGROUP 3 High Temperature Storage	3.19	1008	Units placed in oven at 85°C for 24 hrs.	Thelco Oven Thermometer	N/A
End Point Electrical Parameters			Subgroups 1,4,7 of Table III		
SUBGROUP 4 Operating Life	3.20	1005 Cond. B	Modules biased per subgroups 1,2,4,7 & 8 per Table III with P_{opt} of 1 μw & temp 71°C		
End Point Electrical Parameters			Per subgroups 1,4 and 7 of Table III.		

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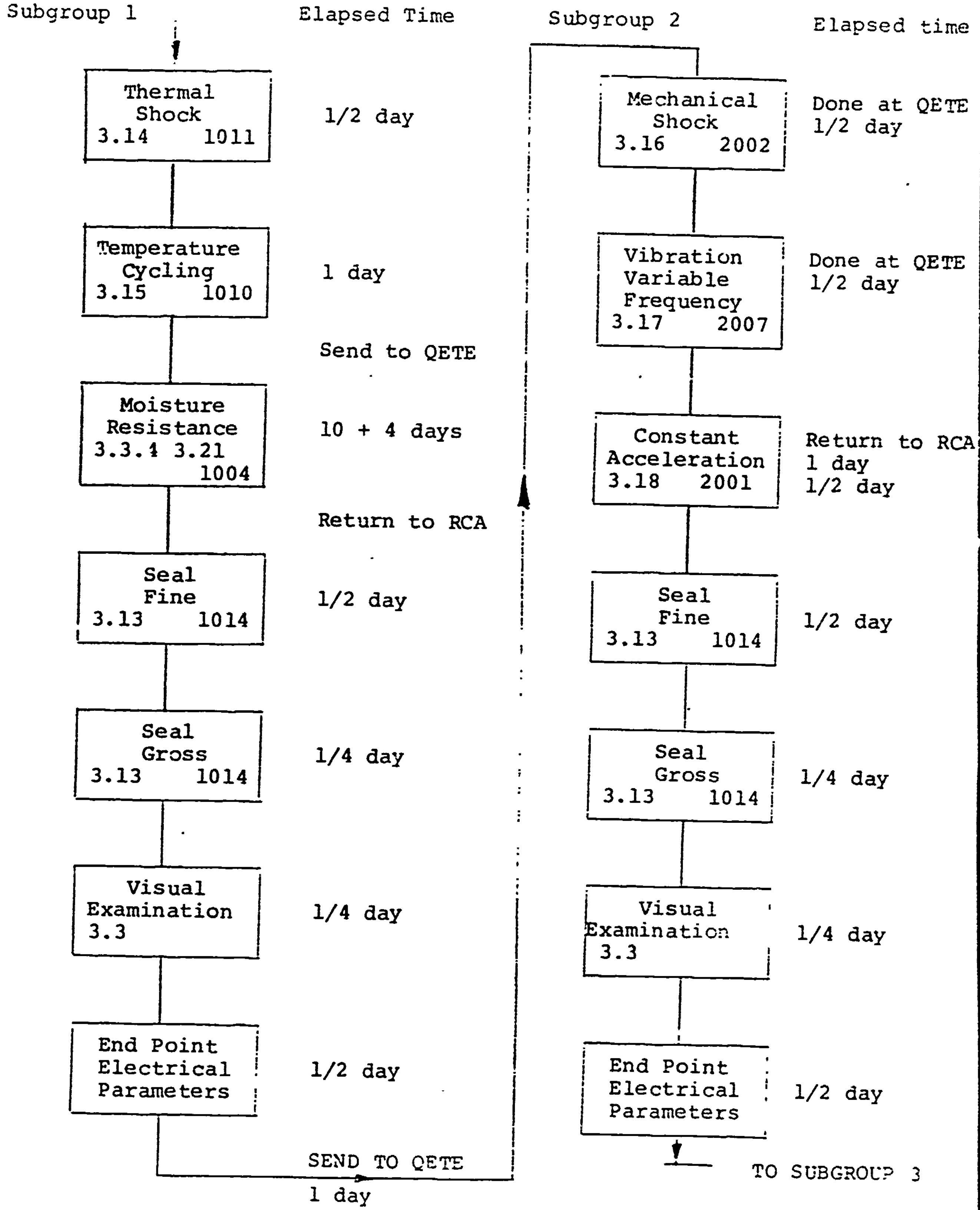
SAPDM-2

GROUP C



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REV.

GROUP C TESTS

Subgroup 3

High Temperature Storage
3.19 1008 — 1 day

End Point ELECTRICAL Parameters — 1 day

To Subgroup 4

Subgroup 4

Operating Life
3.20 1005 — 43 days

End Point Electrical Parameters — 1 day

SECTION 4

COMPOSITE FLOW DIAGRAM

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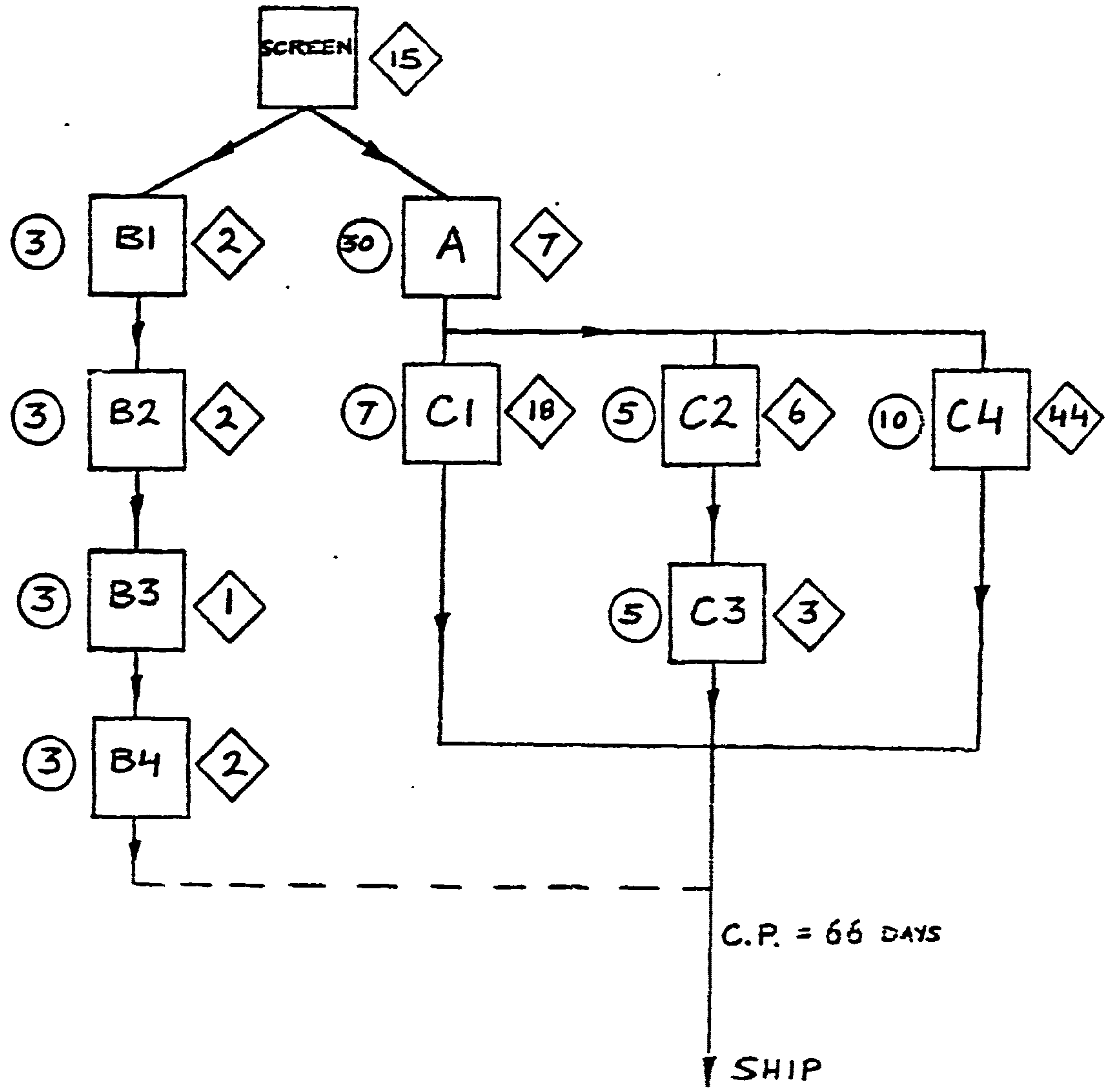
6. COMPOSITE FLOW DIAGRAM FOR SAPDM-1 (MMT-769776-2) and SAPDM-2 (MMT-769776-3)

FINAL TEST BLOCK SUMMARY

TEST SEQUENCE (GROUP/SUBGROUP)

NO. OF UNITS

DURATION (DAYS)



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8.1.9 Pilot Production Run

The pilot production run units were fabricated and tested without any technical problems of significance, and no failures were encountered. The pilot line demonstration for U.S. Army personnel was held on August 28th, 1979, and production and testing was completed at the end of October. This was followed on November 27, 1979 by the Product Capability Demonstration for representatives of government and industry.

8.2 Fabrication Processes

The flow charts of the fabrication process used on each module are presented in this section. Following the flow charts is a description of the processes at each step together with the requirements in equipment and tooling. All the processes used are standard in the hybrid electronics industry. However, the methods by which proper alignment of the light-pipe and photodiode we achieved do warrant special description.

First of all, the light-pipes are removed from their wax packing and thoroughly cleaned and inspected for dimension and freedom from scratches, chips and so on. The hole in the connector cover is inspected by feeler gauge for diameter, straightness, burrs, etc. The hole in the cover is doubly-counterbored because of the mechanical difficulty in drilling such a fine hole over a large distance, without wandering of the tool.

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Epoxy is applied to the outside of the light-pipe and a centering washer placed over one end. The light-pipe is then carefully inserted, using special tweezers, from the top of the connector. The epoxy fills the first counterbore forming a hermetic seal. The centering washer rests in the outer counterbore, where it is held in place by the epoxy bond.

8.2 Fabrication Processes (cont'd)

The correct depth positioning is achieved by a gauge formed from a fiber termination ferrule. This is screwed onto the connector and a central stud pushes the light-pipe to the correct depth. The epoxy is then cured in a holder which retains the assembly in a horizontal position. The next step is to measure the positional height difference between the internal end of the light-pipe and the weld flange of the cover. This is done by placing the cover upright on a machined table which has a micrometer shaft set vertically. Using magnifying optics, the gauge is first set flush with the table and then raised until it touches the light-pipe, displacing the cover. The travel is the required dimension.

By computation and knowing the distance between light-pipe and photodiode chip demanded by geometrical and optical specifications, the height to which the chip post must be made can be determined. For large lots, the variation in position due to accumulated tolerances may be controlled to less than 5 mils.

The post height is controlled by machining the post to the correct height after it has been attached to the substrate. This method works quite effectively.

The flow charts for the assembly of the C30944E and C30941E and the flow chart for the sub-assembly of the fibre optic connector for the C30941E are shown in the following pages.

FLOW CHART

A (SIZE)	P6047
CODE IDENT NO. FSC	SHEET CONT'D ON SH

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COMPILED BY	CHECKED BY
R.E. GREDINAL	D L [illegible] 79-5-28

DESCRIPTION

SAPDM-1 (C30944E) ASSEMBLY

FIRST MADE FOR	GRP.
E0&D/SSD	
C30944E	

REVISIONS	
AP. BY D L [illegible]	0
DATE 79-5-28	

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NEXT ASS'Y.

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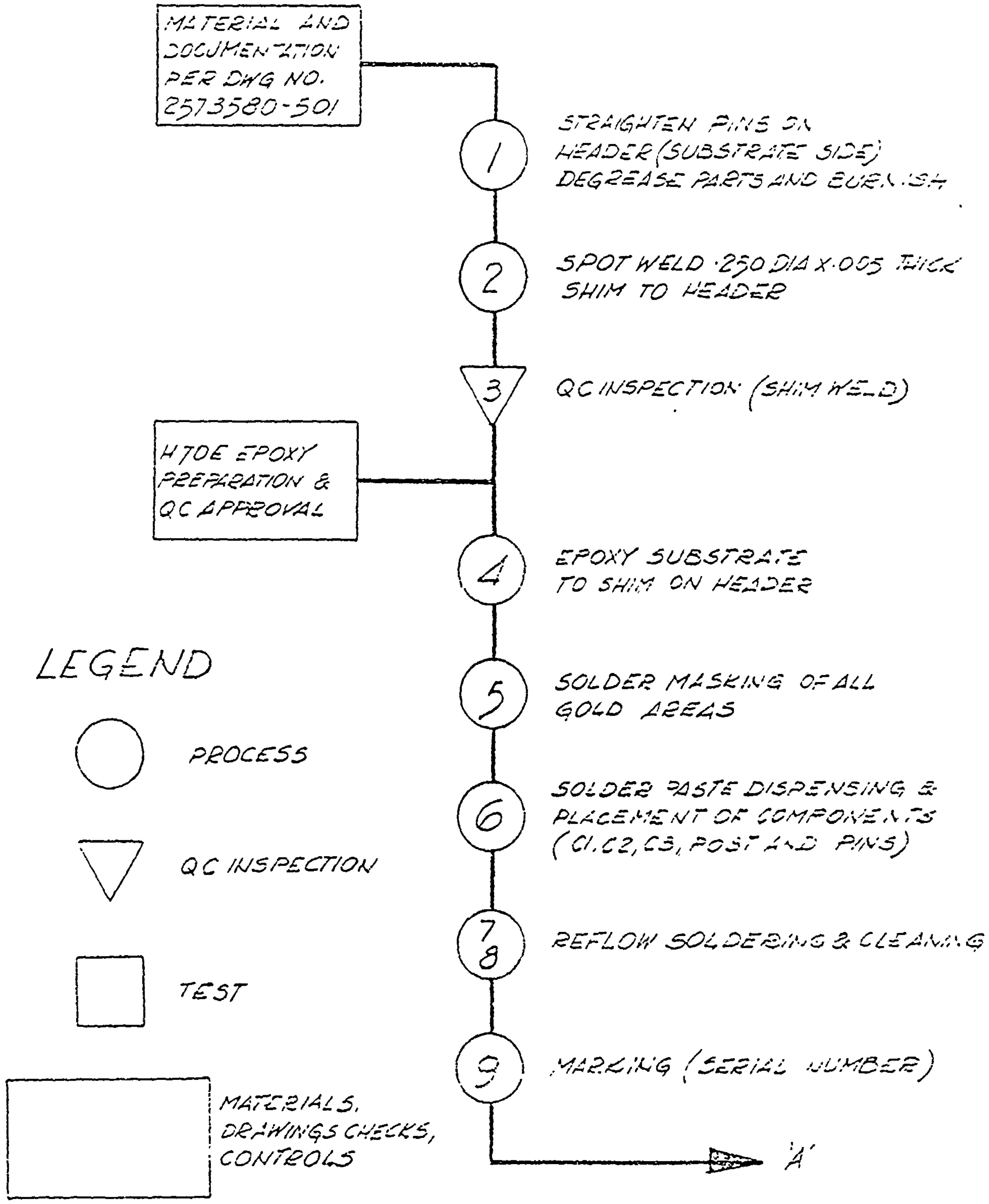
P6047



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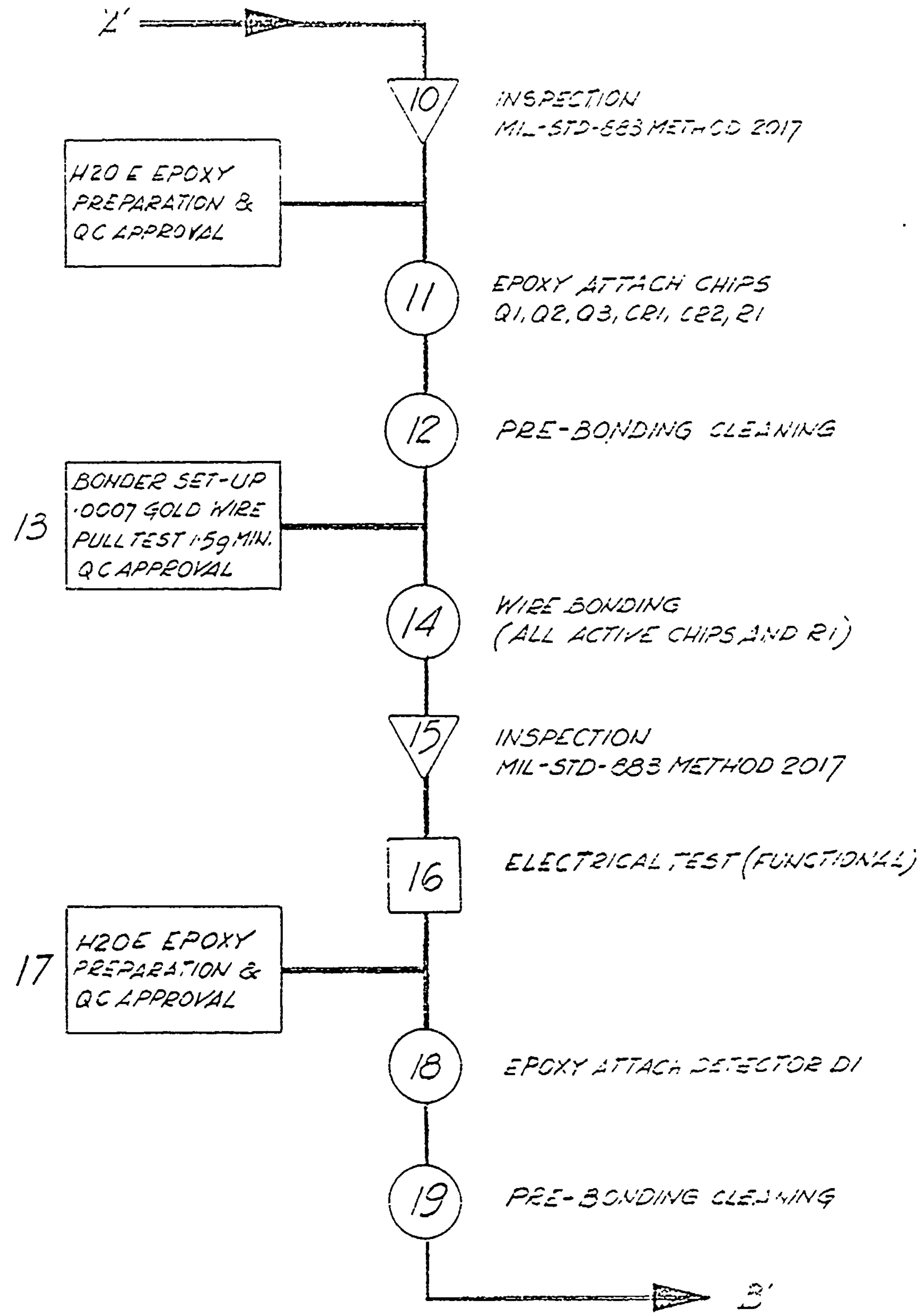

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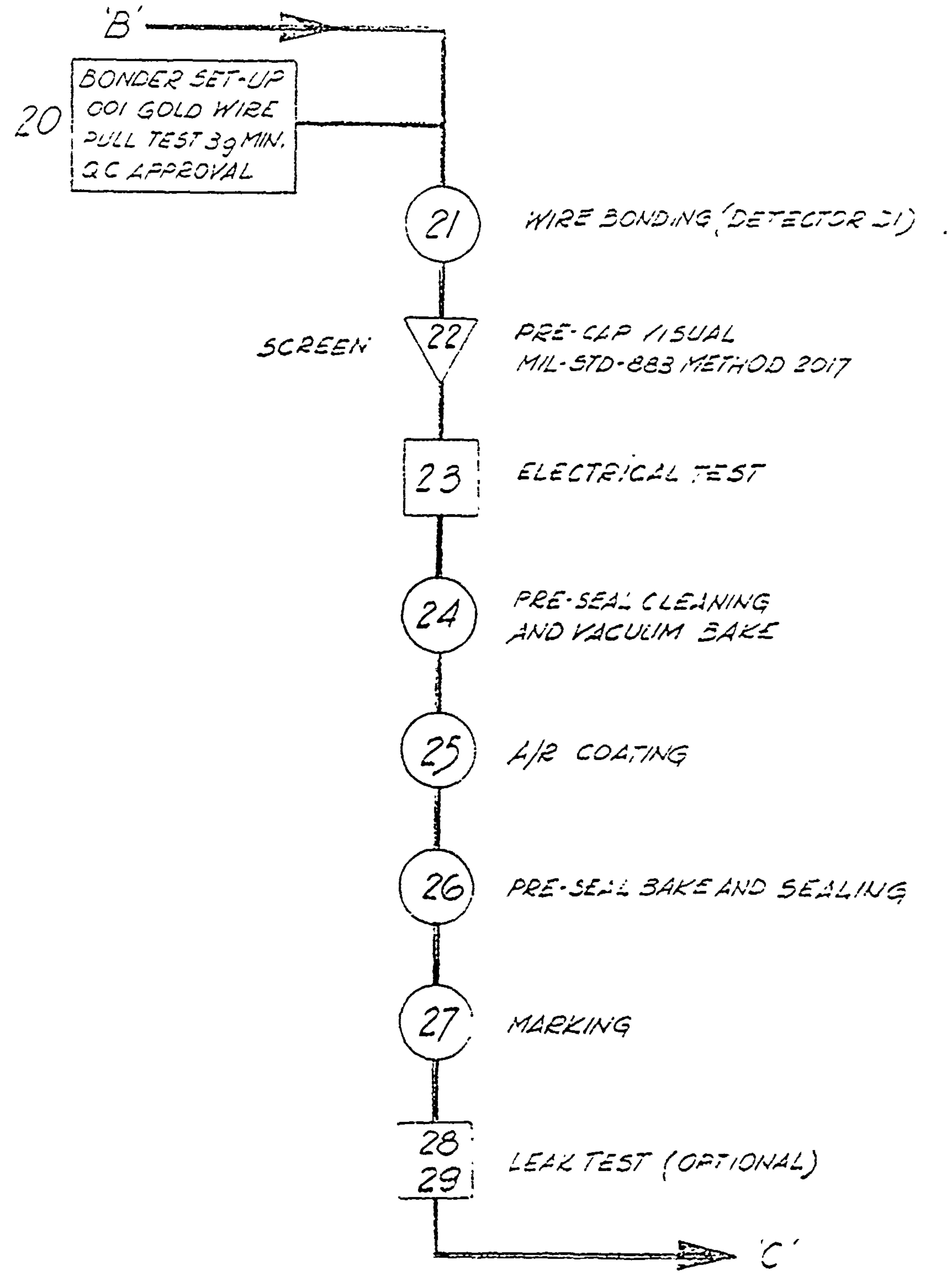
P6047



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A SIZE P6047 REV. 0

CODE IDENT NO. 95311

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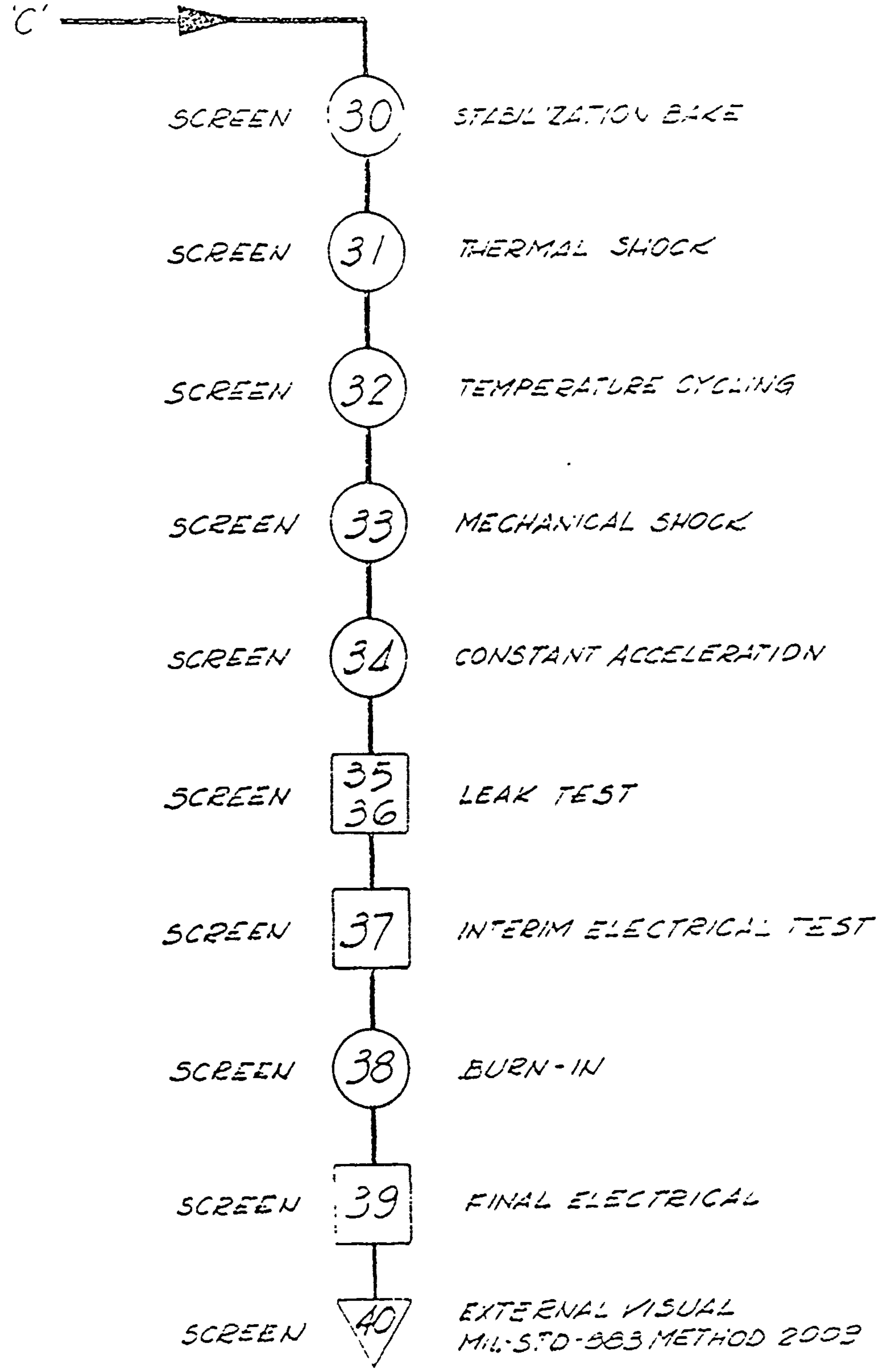
P6047



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FLOW CHART

A	P 6045
CODE IDENT NO.	

COMPILED BY R.E. CARDINAL

CHECKED BY R.K. [illegible] 79-5-28

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STE ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

SAPDM-2 (C30941E)
FIBER OPTIC CONNECTOR
SUB-ASSY

FIRST MADE FOR	GRP.
EOED/SSD	
C30941E	

REVISIONS

AP BY R.K. [illegible]	0
DATE 79-5-28	X

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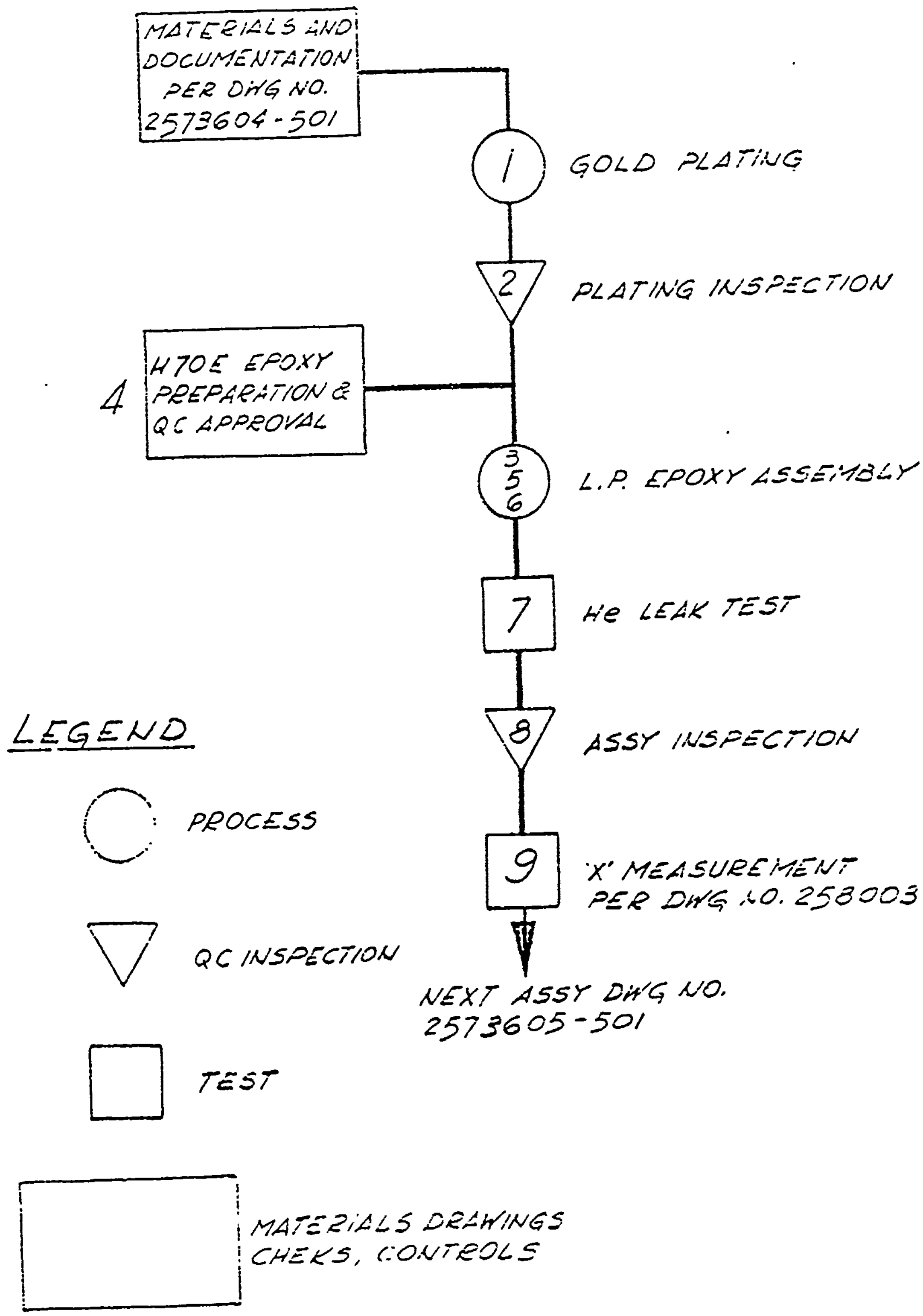

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A SIZE — P6045 — REV. 0

CODE IDENT NO 95317 SHEET — CONT'D ON SH

FLOW CHART

A P6046

SIZE CODE IDENT NO. FSCM | SHEET C CONT'D ON SH.

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COMPILED BY R.E CARDINAL

CHECKED BY D.I [illegible]

DESCRIPTION

SAPDM-2 (C30941E) ASSEMBLY

FIRST MADE FOR	GRP
EOED/SSD	
C30941E	

CONT

REVISIONS

AP. BY	D.I [illegible]	0 X
DATE	79-5-28	

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NEXT ASS'Y.

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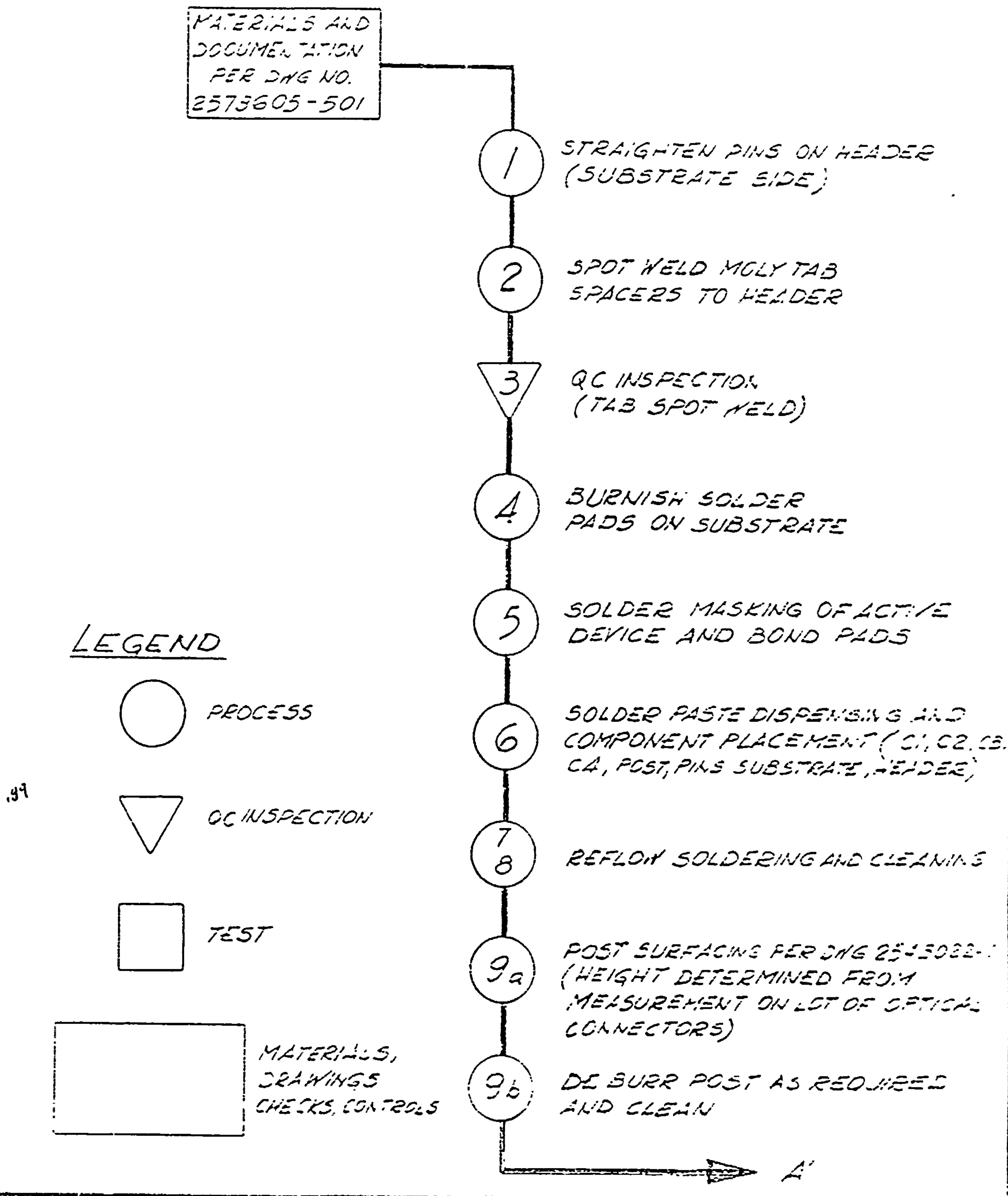
STE ANNE DE BELLEVUE QUEBEC

P6046



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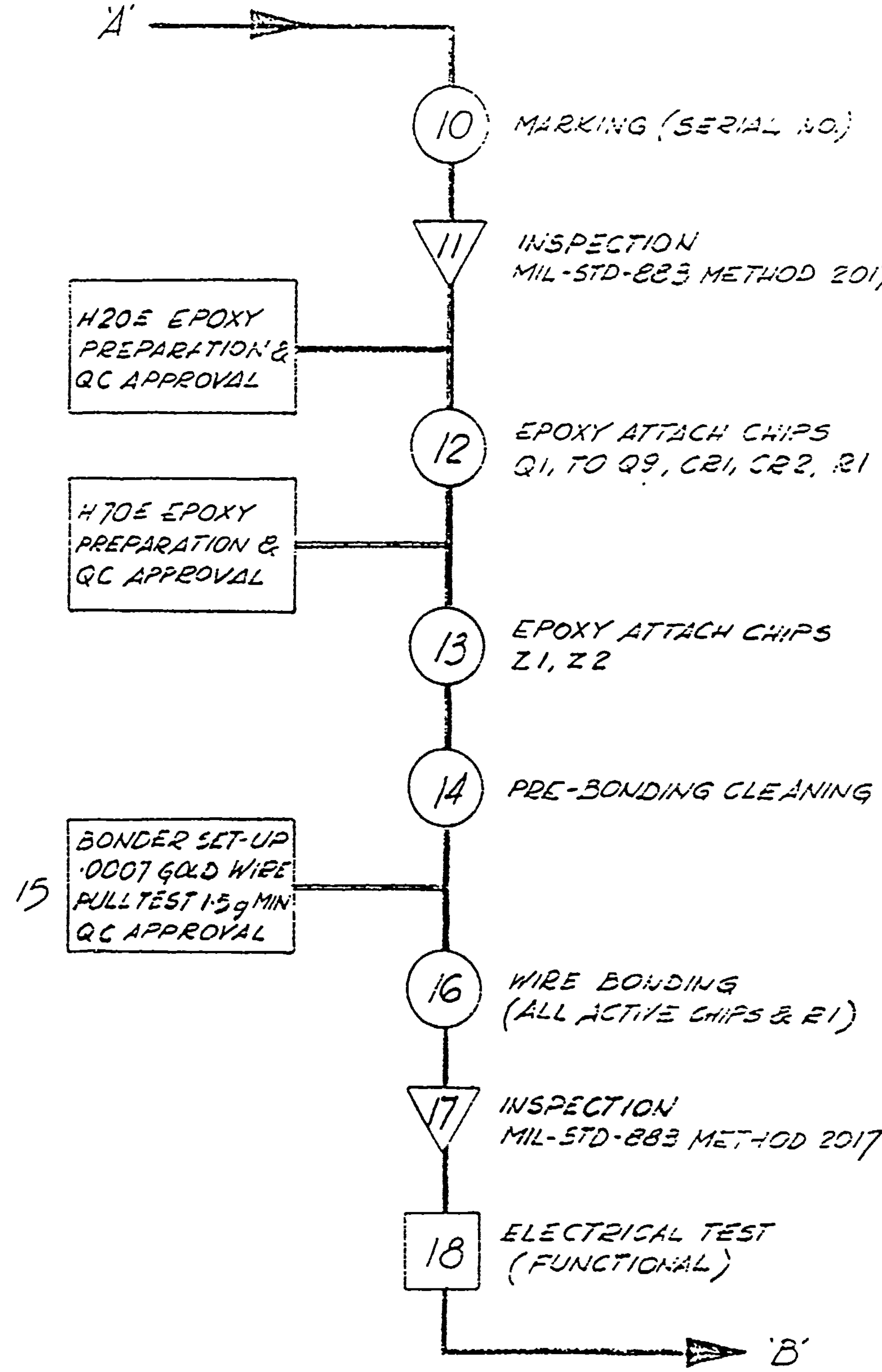
P 6046



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A SIZE | P 6046 | REV. 0

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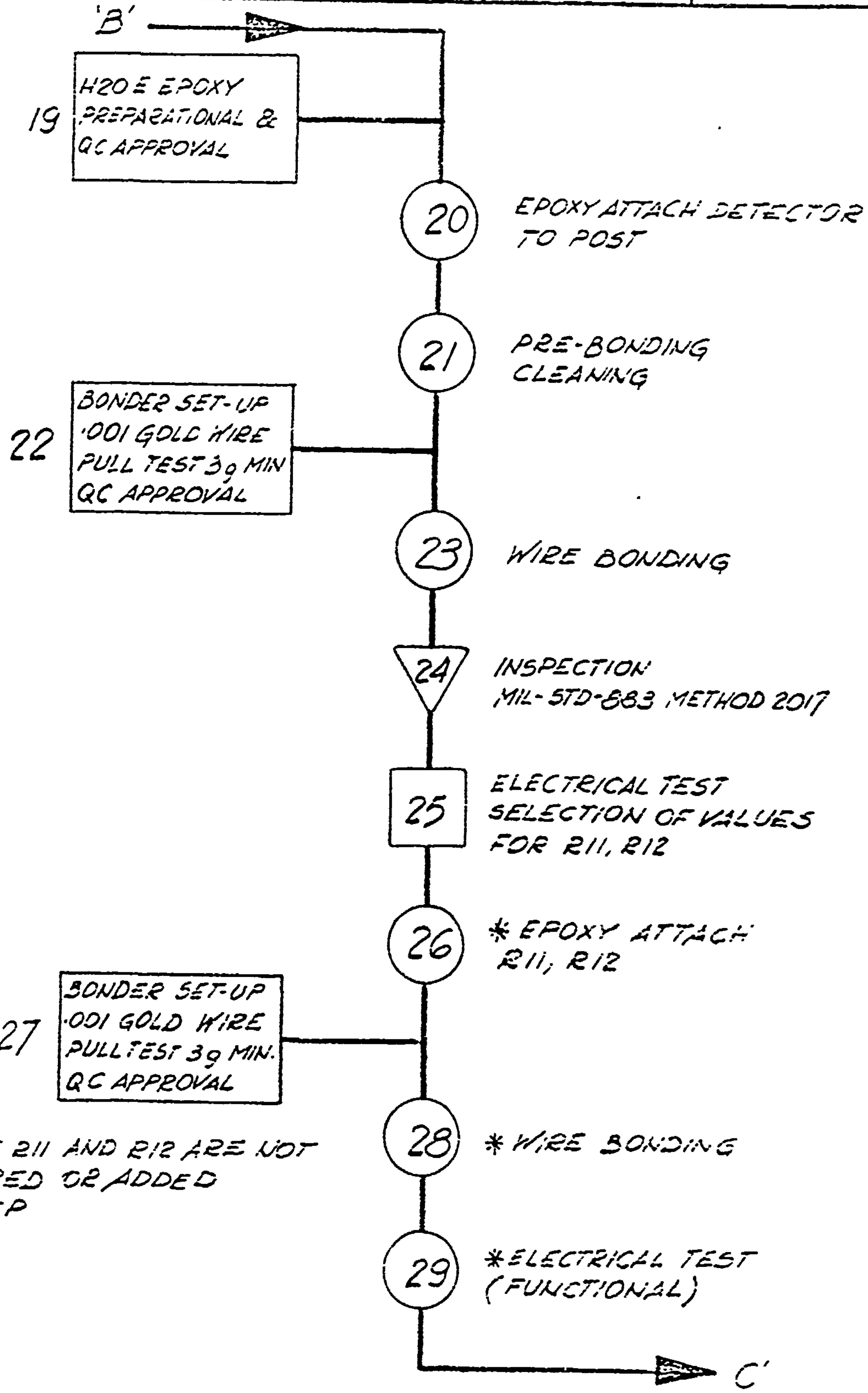

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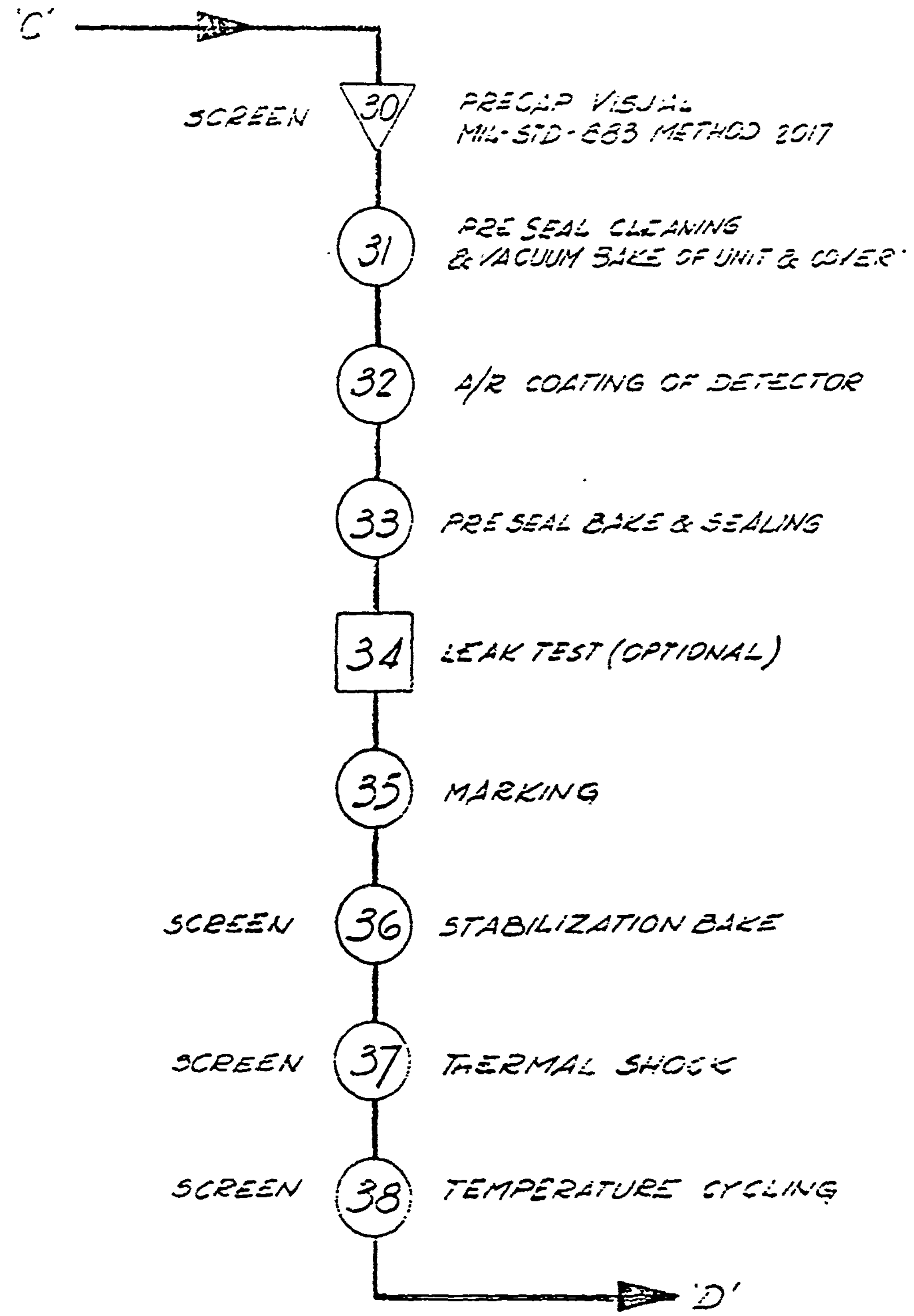
* SKIP IF R11 AND R12 ARE NOT REQUIRED OR ADDED AT STEP


'C'
SCREEN
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PRECAP VISUAL
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31
PRE SEAL CLEANING
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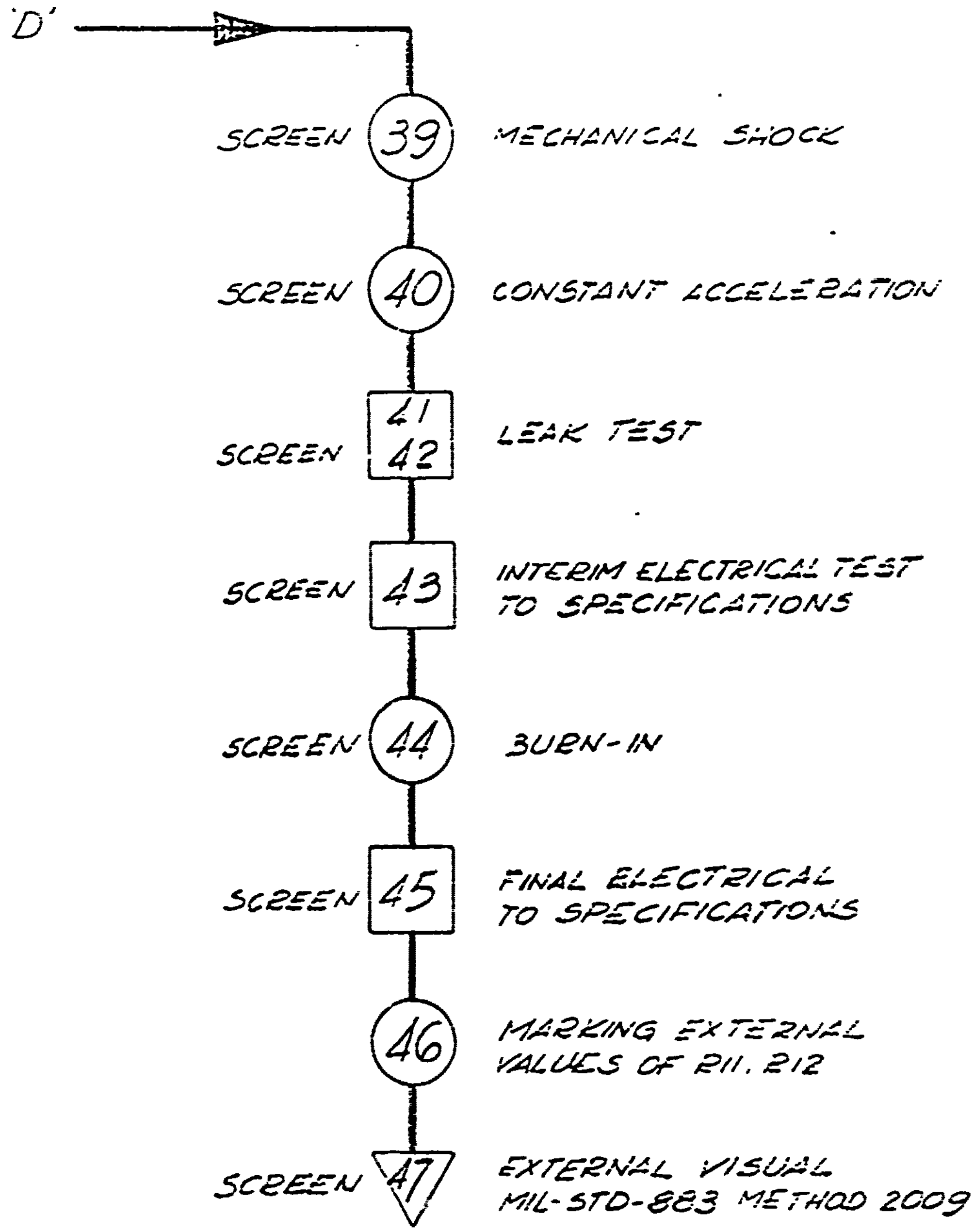
'D'
SCREEN 39 MECHANICAL SHOCK
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SCREEN 43 INTERIM ELECTRICAL TEST TO SPECIFICATIONS
SCREEN 44 BURN-IN
SCREEN 45 FINAL ELECTRICAL TO SPECIFICATIONS
46 MARKING EXTERNAL VALUES OF R11, R12
SCREEN 47 EXTERNAL VISUAL MIL-STD-883 METHOD 2009

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8.2.2 Equipment and Tooling for each Assembly Station and Operations accomplished, including step-by-step description.

Gold Plating

Sub-contracted to:
SPAR Aerospace Ltd.
Ste. Anne de Bellevue,
Quebec, Canada

Plating Inspection

Equipment & Tooling:

Oven 120°C
A/O Zoom microscope

Operation: 16 hrs bake, tape test
inspect for peeling,
blistering, discoloration.

Epoxy Preparation & Q.C. Approval :
(H20E, H70E)

Equipment & Tooling:

Scale Sartorius 1106 (200g)

Operation: weight equal amounts of
both epoxy components and
mix in plastic dish using
metal spatula.

Bake sample on glass slide
for one hour at 120°C.
Test by Q.C. for hardness
using scalpel.

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L.P. Epoxy Assembly:

Equipment & Tooling:

Stereo zoom microscope
Baking jig
Oven 85°C
L.P. depth gauge
Special tweezers

Operation: inspect L.P.
inspect hole with drill
put centering washer on L.P.
put H70E on L.P.
put L.P. in connector from top
screw depth gauge on connector
push light pipe to rest on gauge
bake horizontally at 85°C for one hour.

<u>He Leak Test:</u>
(Cap with L.P.)

Equipment & Tooling:

Veeco He Leak tester
Test jig with O-ring for part to be tested.

Operation:
- put unit on jig
- cycle Veeco for leak detection
- spray outside of part with helium using gun.

<u>Q.C. Inspection:</u>

Equipment & Tooling:

A/O Stereo Zoom Microscope
Unitron 1174 measurement microscope
Measurement calipers

<u>'X' Measurement:</u>

Equipment & Tooling:

Starrett inverted depth gauge on stand
Magnifying glass with light

Operation:
- mount cover with L.P. on gauge.
- adjust gauge till it reaches L.P. (cover moves).
- record value on batch sheet.

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<u>Pin Straightening:</u>

Equipment & Tooling:

Pin Straightener

Operation:
- push header (substrate side) on pin straightener.

<u>Spot Welding:</u>

Equipment & Tooling:

Unitek Welder 1-156
Unitek Weld Head 2-101
Copper alloy jig
#2 electrode

Operation:
- spot weld shim or moly tab on header
5 welds per part

Epoxy Substrate to Header:

Equipment & Tooling:

Support jig
Oven 120°C

Operation:
- -apply epoxy to shim
- -place substrate over pins and push down on epoxy.
- -bake 1 hour at 120°C.

Burnishing :

Equipment & Tooling:

Pink pencil eraser
Singlex 1207

Operation:
- -erase/burnish all soldering pads on substrate.

Degreasing :
(Headers and substrate)

Equipment & Tooling:

Hot plate
Teflon jig

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Operation:
- -boil parts in 1:1:1 Trich, Meth, Acetone mixture for 5 minutes.
- -blow dry with N_2 gun.

Solder Masking:

Equipment & Tooling:

Support jig
Stereo Zoom microscope
Hypodermic needle ÷26G½

Operation:
- -apply lancer 397R solder masking to all gold areas and under all capacitors.
- -room temperature dry 5 min. minimum.

Solder Paste Dispensing: Equipment & Tooling:

EFD 1000D
Blue dispenser needle
Stereo zoom microscope
support jig

Operation: -apply solder paste on all soldering pads and pins
-place components in locations.

Reflow Soldering: Equipment & Tooling:

Browne LR-6

Operation: -place part and jig on feed plate.
-push one unit on belt with 6" to 8" spacing per part.
-correct part positioning and add solder where missing when part is in the solder reflow region.

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Solder Flux Residue Cleaning : Equipment & Tooling:

Branson 125 vapour degreaser
Basket
Kester 5130 solvent

Operation: -3 min. in boiling sump
-3 min. in ultrasonic
-3 min. in boiling sump
-3 min. in ultrasonic
-3 min. in vapour zone.

Post Surfacing:

Equipment & Tooling:

Bridgeport milling machine
Special magnetic jig to support header.

Operation:
- place header in jig.
- mill post to height specified on batch sheet.

Marking:
Wornow 1030 (Serial)

Equipment & Tooling:

Jan-Tech offset printing machine
Jan-Tech numbering head
Oven 120°C.

Operation:
- deposit ink on plate.
- set start serial number
- print on pad
- press part on pad
- bake 2 hours at 120°C.

Marking:
(Markem 7117)

Equipment & Tooling:

Ink plate & roller
Rubber stamps
Oven 85°C.

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Operation:
- Deposit ink on plate
- stamp part manually using rubber stamp.
- bake 30 minutes at 85°C.

Marking:
(Overcoat 1987073)

Equipment & Tooling:

As per Epoxy preparation
Paint brush
Oven 85°C.

Operation:
- Mix epoxy as per specification 1987073.
- paint over 7117 marking
- bake one hour at 85°C

Epoxy Chip Attachment : Equipment & Tooling:

Alignment microscope*
West Bond model 7200
Jig for West Bond
Oven 120°C
Vacuum pick tool (manual).

Operation:
- -Prepare epoxy and load cartridge
- -load chips on circular pick-up platter
- -dispense epoxy dot on mounting pad
- -pick-up chip with machine and place on pad
- -align detector to center of header*
- -bake one hour at 120°C.

* used for detector only

Pre-bonding Cleaning:

Equipment & Tooling:

Cobehn spray equipment
Beakers
Hot plate

Operation:
- -Spray with cobehn*
- -spray with methanol*
- -dip in 2 beakers of boiling methanol
- -dry with N_2 gun.

* not performed on detectors

Wire-Bonding: Equipment & Tooling:

Mech-El	NU-929
K & S	479
K & S	472
Heated work holders	

Operation:
- -Set up bonder, perform pull test on identical bond surfaces, obtain Q.C. approval.
- -load part in jig and bond as per drawing.

Pre-Seal Cleaning
& Vacuum Bake :

Equipment & Tooling:

Hot plate
Beakers
Fisher Vac Oven 120°C

Operation:
- Set-up 2 beakers of methanol to boil
- dip part face down in both beakers
- air dry
- vacuum bake 16 hours at 120°C.

A/R Coating:

Equipment & Tooling:

Veeco evaporator E4-356-105
Masking jig
Sloan DTM Thickness monitor

Operation:
- Vacuum of 2×10^{-6} torr
- evaporate silicon monoxide
- control thickness, visually on test silicon slide, use DTM for coarse thickness control only.

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Pre-Seal Bake
& Sealing :

Equipment & Tooling :

Thomson 2400 welder
Oven 120°C
Appropriate electrodes

Operation:
- Store parts in oven for 1 hour minimum.
- Set-up welder and obtain Q.C. approval for set-up
- load part in welder and weld.

Leak Test (Fine) : Equipment & Tooling:

Veeco He leak tester
Pressurization chamber

Operation:
- -Pressurize parts for 1 hour at 75 psig
- -leak test to $5x10^{-7}$ within 0.5 hr of removal from pressure chamber.

Leak Test (Gross): Equipment & Tooling:

Trio-Tech 481 Bubble tester
Thermometer
Basket

Operation:
- -Check that fluorocarbon is at $125^{o}C \pm 5^{o}C$.
- -Load parts in basket in one row and at 45^{o} to the vertical.
- -Check for bubble stream for 30 sec.

Stabilization Bake: Equipment & Tooling:

Oven $85^{o}C$

Operation:
- -Bake parts for 24 hours.

Thermal Shock : Equipment & Tooling:

2 large beakers
Hot plate
Thermometer

Operation:
- -Set-up one beaker of water to boil.
- -Set-up one beaker of ice water.
- -await till ice water is at $0^{o}C$.
- -perform test as per MIL-STD-883, Method 1011.

<u>Temperature Cycling</u>: Equipment & Tooling:

Delta 3900 CDS automatic
chamber with 9308C programmer
LN_2 supply for cooling
H.P. Digital thermometer
and recorder.

Operation: -Load parts in chamber
-set cycle as per MIL-STD-883
method 1010
-start automatic cycle
-record temperature cycle
on recorder.

<u>Mechanical Shock</u>: Equipment & Tooling:

AVCO Model SM-105

(Sub-contracted to
Quality Engineering
Test Establishment
Department of
National Defence,
Government of Canada,
302 Hull, Quebec)

Operation: -as per MIL-STD-883 method
2002 test Condition B
(0.5 mS, 1500 G)

<u>Constant Acceleration</u>: Equipment & Tooling:

IEC Centrifuge 2-K
Jig for multiple axis.

Operation: -Load parts in multiple
axis jig
-centrifuge part for 1 min.
at 5000 G for each axis.

<u>Electrical Test</u>: Equipment & Tooling:

As per Test Plan report

Operation: -As per Test Plan report.

<u>Burn-in</u> : Equipment & Tooling:

As per Test Plan report.

Operation: -As per Test Plan report.

8.2.3 Estimate of Yield for Each Operation

A starting quantity of 200 units is assumed. The quantity left at the end of that operation is noted. The operation numbers are for cross-reference to the flow charts. Only major operations are listed.

SAPDM-1 Assembly (Ref. Flow Chart P6047)

No.	Operation	Qty Good	Operation Yield
--	Starting quantity	200	--
1 to 10	Substrate & Component soldering.	183	92%
11 to 15	Active chip epoxy attachment and wire bonding.	181	99%
16	Electrical Test	178	98%
17 to 23	Detector attachment, bonding, electrical test, precap visual.	170	96%
24 to 29	A/R coating, seal, marking, leak test.	157	92%
30 to 36	Environmental screen.	150	95%
37	Interim Electrical.	130	87%
38, 39	Burn-in and final electrical.	125	96%
40	External visual	123	98%

OVERALL YIELD : 61%

SAPDM-2 Optical Connector (Ref. Flow Chart P6045)

No.	Operation	Qty Good	Operation Yield
--	Starting quantity	200	---
1 to 7	Epoxy L.P. to connector and leak test.	191	95%
8	Q.C. Visual Inspection	187	98%
9	X Measurement	185	99%

OVERALL YIELD : 92%

SAPDM-2 Assembly (Ref. Flow Chart P-6046)

No.	Operation	Qty Good	Operation Yield
---	Starting quantity	200	---
1 to 11	Substrate & Component soldering	190	95%
12 to 17	Active chip epoxy attachment and wire bonding.	188	99%
18	Electrical Test	146	78%
19 to 30	Detector Attachment, bonding electrical test.	137	94%
31 to 35	A/R coating, sealing, marking leak test.	136	99%
36 to 42	Environmental screen	130	96%
43	Interim electrical	110	85%
44, 45	Burn-in and final electrical	105	95%
46, 47	External visual	103	98%

OVERALL YIELD : 51%

8.2.4 Yield of Pilot Line

It may be observed that the principal factor in reduction of yields for these devices is electrical in nature and is observed during the various interim electrical tests that are performed. In some cases, the unit may be successfully re-worked, but this cannot be relied upon. Electrical faults consist either in failure of the thick film circuit in some random way, or more likely deterioration of the discrete components used in the assembly, such as transistors, integrated circuits and sometimes the avalanche photodiode. RCA Electro Optics in Montreal is not primarily a microelectronic oriented operation and we believe that more experience and familiarity with this design will be helpful. Specifically, for large quantities of devices, the purchase of a suitable wire bonding machine is likely to solve several problems associated with the miniature electronic components used.

8.2.5 Production Capacity of Each Station

Note: Production rates are given in SAPDM-1 and SAPDM-2 units per day unless noted otherwise. (8hr/day and 40hr/week). One operator per station.

Gold Plating:	200/day
Plating Inspection:	200/day
Epoxy Preparation & Q.C. Approval: (H20E, H70E)	20 epoxy batches/day
L.P. Epoxy Assembly:	50/day
He Leak Test: (Cap with L.P.)	200/day
Q.C. Inspection:	200/day
'X' Measurement:	400/day
Pin Straightening:	400/day

Spot Welding:	400/day	(SAPDM-1)
	200/day	(SAPDM-2)
Epoxy Substrate to Header :	300/day	
Burnishing :	400/day	
Degreasing: (Headers & substrate)	400/day	
Solder Masking:	300/day	(SAPDM-1)
	200/day	(SAPDM-2)
Solder Paste Dispensing:	100/day	(SAPDM-1)
	50/day	(SAPDM-2)
Reflow Soldering:	300/day	
Solder Flux Residue Cleaning:	400/day	
Post Surfacing:	200/day	

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<u>Marking</u>: Wornow 1030 (Serial)	150/day
<u>Marking</u>: (Markem 7117)	150/day
<u>Marking</u>: (Overcoad 1987073)	150/day
<u>Epoxy Chip Attachment</u>:	100/day (SAPDM-1) on two machines 60/day (SAPDM-2) on two machines
<u>Pre-bonding Cleaning</u>:	200/day
<u>Wire Bonding</u> :	60/day (SAPDM-1) on two machines 35/day (SAPDM-2) on three machines
<u>Pre Seal Cleaning</u> <u>& Vacuum Bake</u> :	400/day

A/R Coating:	100/day	(SAPDM-1)
	50/day	(SAPDM-2)
Pre Seal Bake & Sealing :	150/day	
Leak Test (Fine):	200/day	
Leak Test (Gross):	400/day	
Stabilization Bake:	400/day	
Thermal Shock :	100/day	
Temperature Cycling:	400/day	
Mechanical Shock:	45/day	(SAPDM-1)
(Sub-contracted to Quality Engineering Test Establishment, Department of National Defence, Government of Canada, Hull, Quebec)	30/day	(SAPDM-2)

<u>Constant Acceleration</u>:	30/day	
<u>Electrical Test</u>:		
(all electrical testing)	57/day (SAPDM-1) on two test stations	
	40/day (SAPDM-2) on three test stations	
<u>Burn-in</u>:	150/week (SAPDM-1) 136/week (SAPDM-2)	

8.3 Equipment and Tooling

Replacement cost of capital equipment for production of 100 units per week.

OPERATION	SAPDM-1 Cost ($)	SAPDM-2 Cost ($)
1. Inspection (plating)		
Oven 120°C	-	800
Microscope stereo zoom	-	1000
2. Epoxy Preparation		
Scale	1000	1000
3. Light-Pipe Epoxy Assembly		
Microscope stereo zoom	-	1000
Jig curing		200
Oven		800
Assembly jigs & tools		200
4. He Leak Test (light-pipe cover sub-assembly)		
for equipment see line 25		
Special Test jig He gun	-	400
5. Inspection (general)		
Stereo zoom microscope	1000	1000
Measuring microscope	10000	10000
Measuring tools	100	1000
6. "X" Measurement		
Depth gauge	-	100
Illuminator	-	100
7. Pin Straightening		
Tool	200	200
8. Spot Welding		
Welding machine	2300	2300
Jigs	100	100
9. Epoxy Substrate to Header		
Support jigs	200	200
Oven	800	800
10. Burnishing		
Manual no jigging or equipment	-	-

8.3 Equipment and Tooling (cont'd)

11. Degreasing		
Hot plate	100	100
Teflon jig	150	150
12. Solder Masking		
Support jigs	500	500
Stereo zoom microscope	1000	1000
13. Solder Paste Dispensing		
Paste dispenser	600	600
Stereo zoom microscope	1000	1000
14. Reflow soldering		
Belt solder reflow machine	6000	6000
15. Flux Residue Cleaning		
Vapour degreaser	3000	3000
16. Post Surfacing		
Milling machine	-	15000
Magnetic jig	-	1000
17. Marking (serial #)		
Offset printer with	3000	3000
serialization head oven	800	800
18. Marking and Overcoat (manual)		
Tooling	50	50
Oven	800	800
19. Epoxy Chip Attachment		
Alignment microscope	1500	1500
Epoxy bonder	6000	6000
Jig	500	500
Oven	800	800
Tooling	150	150
20. Pre-Bonding Cleaning		
Spray equipment	1000	1000
Hot plate	100	100

8.3 Equipment and Tooling (cont'd)

21. Wire Bonding		
Wire bonde	2 x 8000=16000	3x8000 =24000
Heated wc holder	2 x 1000= 2000	3x1000 = 3000
22. Pre-seal Cleaning & Vacuum Bake		
Hot plate	100	100
Vacuum oven	3000	3000
23. Air Coating		
Evaporator	15000	15000
Support jigs	1000	1000
Thickness monitor	3500	3500
24. Pre-seal Bake & Sealing		
Oven	800	800
Welder	45000	45000
Electrodes	200	200
25. Leak Testing (fine)		
He leak tester	12000	12000
Pressure chamber	1000	1000
26. Leak Testing (gross)		
Bubble Tester	700	700
Filtration system	1000	1000
Jigs and tooling	100	100
27. Stabilization Bake		
Oven	800	800
28. Thermal Shock		
Hot plate	100	100
Jigs & tooling	100	100
29. Temperature Cycling		
Cycling oven	5000	5000
Temperature recorder	5000	5000
30. Mechanical shock		
Jigs	1000	1500
Shock test machine	10000	10000
31. Constant Acceleration		
Centrifuge	7000	7000
Jigs (6 axis)	2000	2000

8.4 Data Analysis

The following tables list the electro optical characteristics of both the SAPDM-2 (C30941E) and the SAPDM-1 (C30944E). The typical measured values of the characteristics at room temperature are compared with those required by the original specification and those required by the revised specification. In all cases, the typical values measured on the units surpassed those required by the revised specification by a healthy margin.

8.4.1 Responsivity

The responsivity on both units can, to a certain extent, be set at the value desired.

8.4.2 Spectral Output Noise Voltage Density

This is determined by the noise from the photodiode, the noise from the load resistor and the noise from the input transistor, as well as the bandwidth. There was no problem meeting the revised specification.

8.4.3 Bandwidth

This was longer than expected because the circuit layout permitted lower stray capacitance than expected.

8.4.4 Output Swing, Recovery Time, Rise/Fall Times Power Consumption, and Output Impedance were all circuit dependent and easily controlled.

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ELECTRICAL PERFORMANCE CHARACTERISTICS SAPDM-1 (C30944E)

CHARACTERISTICS	ORIGINAL CONDITIONS	ORIGINAL LIMITS MIN MAX	REVISED CONDITIONS	REVISED LIMITS MIN MAX	TYPICAL MEASURED VALUE	UNITS
RESPONSIVITY	λ=1060nm	$1.3x10^5$	λ=1060nm	$2.7x10^5$	$3.4x10^5$	V/W
SPECTRAL OUTPUT NOISE VOLTAGE DENSITY	Δf= 100khz (a) f= 10MHz (b) f=20,30& 48MHz	(a) $3.6x10^{-8}$ (b) $6.0x10^{-8}$	Δf= 10kHz (a) f=1.0MHz (b) f=16,32 & 48MHz	(a) $5.0x10^{-8}$ (b) $1.0x10^{-7}$	(a) $3.5x10^{-8}$ (b) $4.5x10^{-8}$	$V/(Hz)^{\frac{1}{2}}$
OUTPUT SWING		1.0		1.0	1.4	V
BANDWIDTH	-3db	$2.0x10^7$	-3db	$2.0x10^7$	$2.9x10^7$	Hz
RECOVERY TIME	P_{opt}=500mW 5ns	660	P_{opt}=500mW 5ns	660	570	ns
RISE TIME		18		18	12	ns
FALL TIME		18		18	12	ns
POWER CONSUMPTION		75		75	42	mW
OUTPUT IMPEDANCE	f=1.0MHz	50	f=800Hz	50	25	ohms

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ELECTRICAL PERFORMANCE CHARACTERISTICS SAPDM-2 (C30941E)

CHARACTERISTIC	ORIGINAL CONDITIONS	ORIGINAL LIMITS MIN MAX	REVISED CONDITIONS	REVISED LIMITS MIN MAX	TYPICAL MEASURED VALUE	UNITS
RESPONSIVITY	λ=820nm	$6.5x10^{5}$	λ=820nm	$1.3x10^{6}$	$1.6x10^{6}$	V/W
SPECTRAL OUTPUT NOISE VOLTAGE DENSITY	Δf=100kHz (a) f= 1MHz (b) f=16,32 & 48MHz	(a) $2.5x10^{-8}$ (b) $5.0x10^{-8}$	Δf=10kHz (a) f=1.0MHz (b) f=16,32 & 48MHz	(a) $5.0x10^{-8}$ (b) $1.0x10^{-7}$	(a) $3.5x10^{8}$ (b) $4.0x10^{8}$	$V/(Hz)^{\frac{1}{2}}$
OUTPUT SWING		1.0		1.0	1.4	V
BANDWIDTH	-3db	$1.6x10^{7}$	-3db	$1.6x10^{7}$	$2.2x10^{7}$	Hz
RISE TIME		22		22	16	ns
FALL TIME		22		22	16	ns
POWER CONSUMPTION		100		100	66	mW
OUTPUT IMPEDANCE	f=1MHz	50	f=800Hz	50	25	ohms

8.5 Discussion of Specification

The revised specification presented no major problems and looks like a good specification, which will yield useful devices. A discussion of the original specification has been made earlier in this report and need not be repeated here.

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9. Conclusions

From the technical point of view, the program has been outstandingly successful. Also, only minor readjustments in the schedule were required to compensate for the delays encountered in the program. Only the basis for the technology existed at the award date so no comparison with costs and yields at that time has been possible. The principal achievements of note can be summarized under several topics.

(i) A revision of the specification led to the delivery of modules of superior design and performance to those envisaged in the contract.

(ii) Manufacturing methods for both modules have been developed and put into practice.

(iii) Identifiable costs have been attached to the manufacture of both module types.

(iv) Specifically, a valuable contribution was made to the design of the fiber optic module by consolidating the circuitry in a single package.

(v) All the principal goals of the program have been met.

10. Publications and Reports

"New Avalanche photodiodes and detector modules for fiber optics applications"

P. Webb, M.J. Teare and R.H. Buckley

Proc. National Electronics Conference
Vol. XXXI, 1977, p. 349

11. Identification of Personnel

The following is a statement of the total man-hours contributed by each person involved in this contract. Figures are accumulated from June 1, 1977 to November 30, 1979. For simplicity, contributions less than ten (10) hours are omitted.

Contract Administration and Management	Cumulative Man - hours
R.J. McIntyre	22
R.H. Buckley	1303

Engineers and Scientists	Cumulative Man-Hours
P. Webb	88
R. Cardinal	526
M. Teare	1205
A. Strychalski	194
P. Fortin	15
Technologists	
J. Bignet	34
W. Ruta	414
M. Fossiez	598
S. Soltesz	182
R. Tetreault	227
Technicians	
S. Spulnik	48
G. Houghton	214
M. Jordan	383
M. Faltas	45
S. Belec	22
R. Liddy	950
H. Stelzer	221
G. Simpson	144
Operators	
J. Hache	311
L. Carpentier	48
M. Leroux	231
J. Bevan	40
Z. Zizkova	27
W. Terry	157
C. Blais	17
C. Bilodeau	15
R. Chate	11
J. Bosnik	44
K. Daly	18
F. Desrochers	12

U.S. CONTRACT #DAAB07-77-C-0489

placed by

U.S. ARMY ELECTRONIC RESEARCH AND DEVELOPMENT COMMAND

ATTN: DELSC-D-PC

FINAL REPORT
MANUFACTURING METHODS AND TECHNOLOGY MEASURE
FABRICATION METHODS FOR LOW COST HYBRID SILICON PHOTODETECTOR MODULES

June 1, 1977 - December 30, 1979

VOLUME II

220

CONTRACTOR: RCA LIMITED
Trans-Canada Highway
Ste-Anne-de-Bellevue
Quebec, Canada

DISTRIBUTION: Limited to U.S. Government Agencies only

TEST AND EVALUATION: January 13, 1978

Other requests for this document must be referred to: U.S. Army Communications Research and Development Command
Fort Monmouth, N.J. 07703
ATTN: DELSD-D-PC

I N T R O D U C T I O N

This volume of the report describes the procedures and their sequence used to make both the SAPDM-1 and the SAPDM-2 modules. P6045, P6046 and P6047 show the Flow Charts used in the making of the SAPDM-1 and SAPDM-2 modules.

Each step in the Flow Charts is numbered and by using the «Key to the Standard Procedures» tables, one can find the procedure number applicable to any given step in the Flow Chart. These applicable detailed procedures (4000 and P5000 series) are arranged in sequence and form the bulk of the rest of the report.

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KEY TO STANDARD PROCEDURES - P6045

PROCESS STEP NUMBER	APPLICABLE PROCEDURES	METHOD	CONDITIONS
1	N/A		Sub-contracted
2	QM0015		
3	P4052		
4	P4032		
5	P4052		
6	P4052		
7	QM0015		
8	QP0039		
9	P4060		

222

KEY TO STANDARD PROCEDURES - P6046

PROCESS STEP NUMBER	APPLICABLE PROCEDURES	METHOD	CONDITIONS
1	P4061		
2	P4062		
3	QP0041		
4	P4063		
5	P4029		
6	P4029		
7	P4027		
8	P4027		
9	P4064		
10	P4028		
11	MIL-STD-883	2017	
12	P4032		
13	P4032		
14	P4035		
15	QP0027		
16	P4053		
17	MIL-STD-883	2017	
18	P5028		
19	P4032		
20	P4032		
21	P4035		
22	QP0027		
23	P4053		
24	MIL-STD-883	2017	
25	P5028		
26	P4032		
27	QP0027		
28	P4053		
29	P5028		
30	MIL-STD-883	2017	
31	P4008		
32	P4036		
33	P4008		
	P4010		
34	QP0029		
35	P4028		
36	MIL-STD-883	1008	
37	MIL-STD-883	1011	Cond. A
38	MIL-STD-883	1010	Cond. A
39	MIL-STD-883	2002	Cond. B
40	MIL-STD-883	2001	Cond. A
41	MIL-STD-883	1014	Cond. A1
42	MIL-STD-883	1014	Cond. C1
43	P5028	MMT769776-3	Sub. 1 Table III
44	MIL-STD-883	1015	Cond. B (Ta 71°C)
45	P5028	MMT769776-3	Sub. 1 Table III
46	P4028		
47	MIL-STD-883	2009	

KEY TO STANDARD PROCEDURES - P6047

PROCESS STEP NUMBER	APPLICABLE PROCEDURES	METHOD	CONDITIONS
1	P4061		
2	P4062		
3	QP0041		
4	P4029		
5	P4029		
6	P4029		
7	P4027		
8	P4027		
9	P4028		
10	MIL-STD-883	2017	
11	P4032		
12	P4035		
13	QP0027		
14	P4053		
15	MIL-STD-883	2017	
16	P5029		
17	P4032		
18	P4032		
19	P4035		
20	QP0027		
21	P4053		
22	MIL-STD-883	2017	
23	P5029		
24	P4008		
25	P4036		
26	P4008 P4010		
27	P4028		
28	MIL-STD-883	1014	Cond. A1 (optional)
29	MIL-STD-883	1014	Cond. C1 (optional)
30	MIL-STD-883	1008	
31	MIL-STD-883	1011	Cond. A
32	MIL-STD-883	1010	Cond. A
33	MIL-STD-883	2002	Cond. B
34	MIL-STD-883	2001	Cond. A
35	MIL-STD-883	1014	Cond. A1
36	MIL-STD-883	1014	Cond. C1
37	P5029	MMT7697762-2	Sub. 1 Table III
38	MIL-STD-883	1015	Cond. B Ta 71°C
39	P5029	MMT7697762-2	Sub. 1 Table III
40	MIL-STD-883	2009	

FLOW CHART

A (SIZE) P 6045

CODE IDENT NO. 95311 | SHEET 0 | CONT'D ON SH 1

RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

COMPILED BY	CHECKED BY
P.E. CARDINAL	R. R. Cardinal 79-5-28

DESCRIPTION

SAPDM-2 (C30941E)
FIBER OPTIC CONNECTOR
SUB-ASSY

FIRST MADE FOR	GRP.
EO&D/SSD	
C30941E	

CONT.

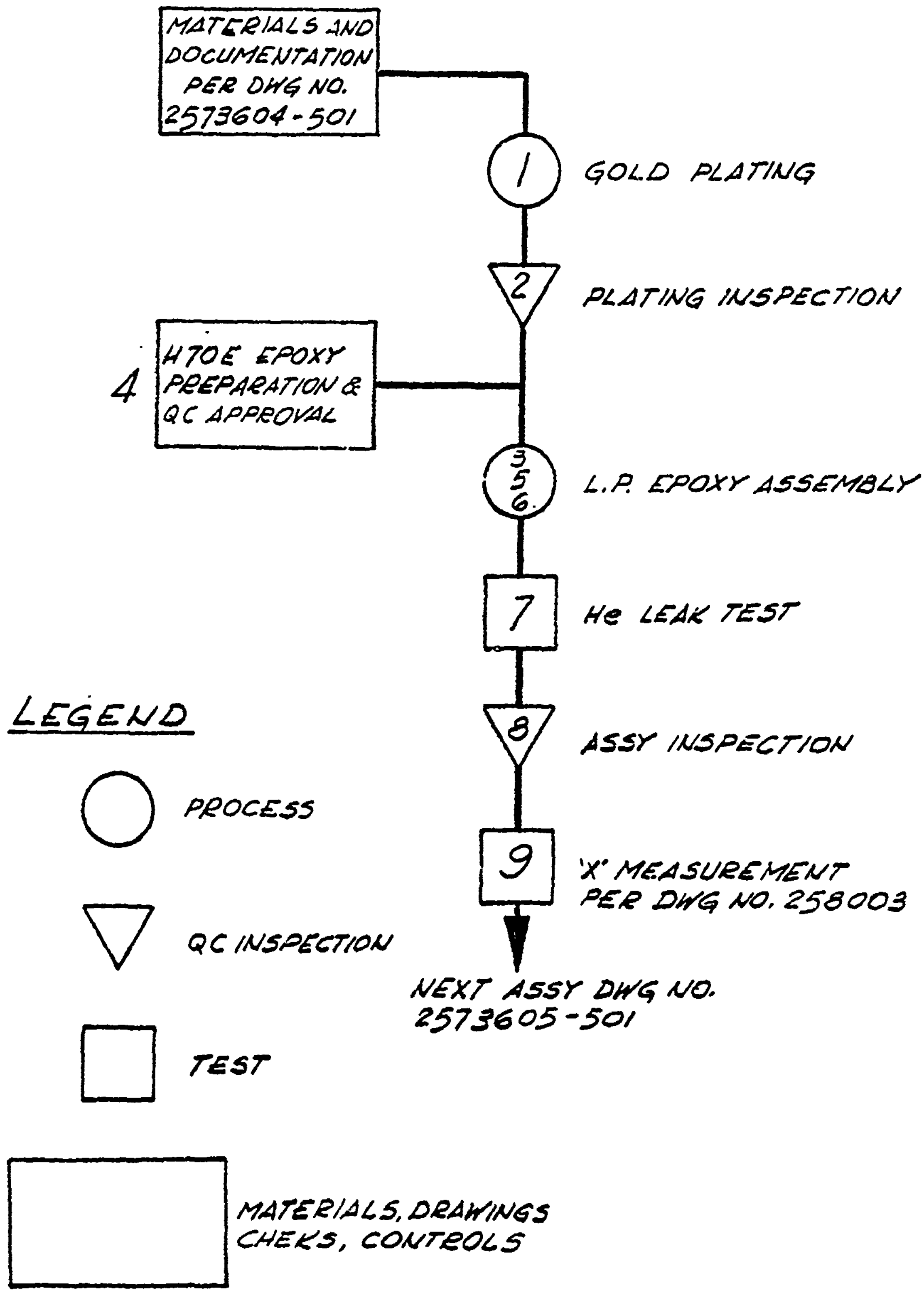
REVISIONS	
AP. BY R. R. Cardinal	0x
DATE 79-5-28	

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

P6045



A SIZE	P6045	REV. 0
CODE IDENT NO 95311	SHEET 7	CONT'D ON SH N/A

FLOW CHART

A SIZE	P6046
CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

COMPILED BY E. CARDINAL

CHECKED BY D. L. Paradis 79-5-28

RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

SAPDM-2 (C30941E) ASSEMBLY

FIRST MADE FOR	GRP.
EO&D/SSD	
C30941E	

CONT.

REVISIONS

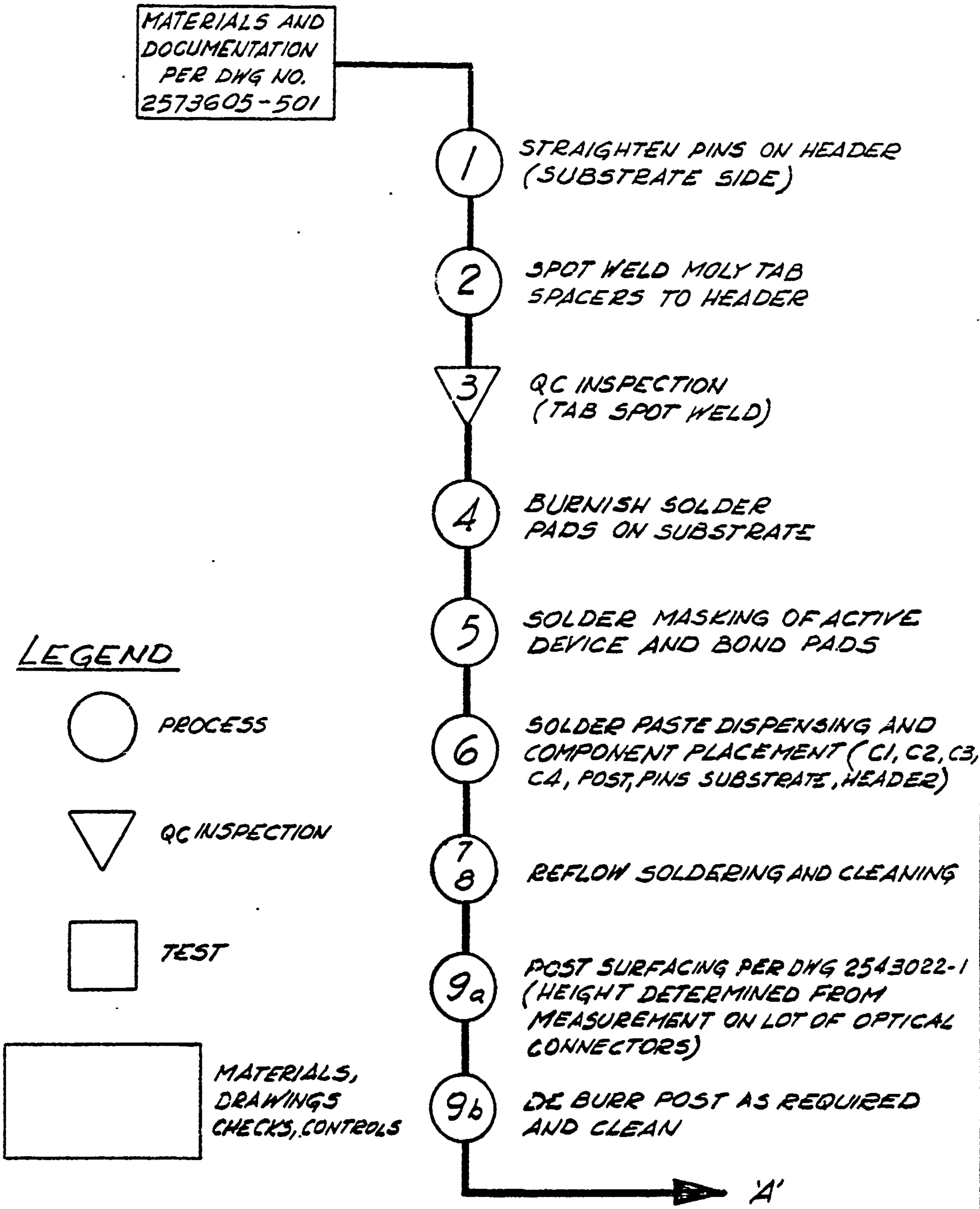
AP. BY	D. L. Paradis	0
DATE	79-5-28	X

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

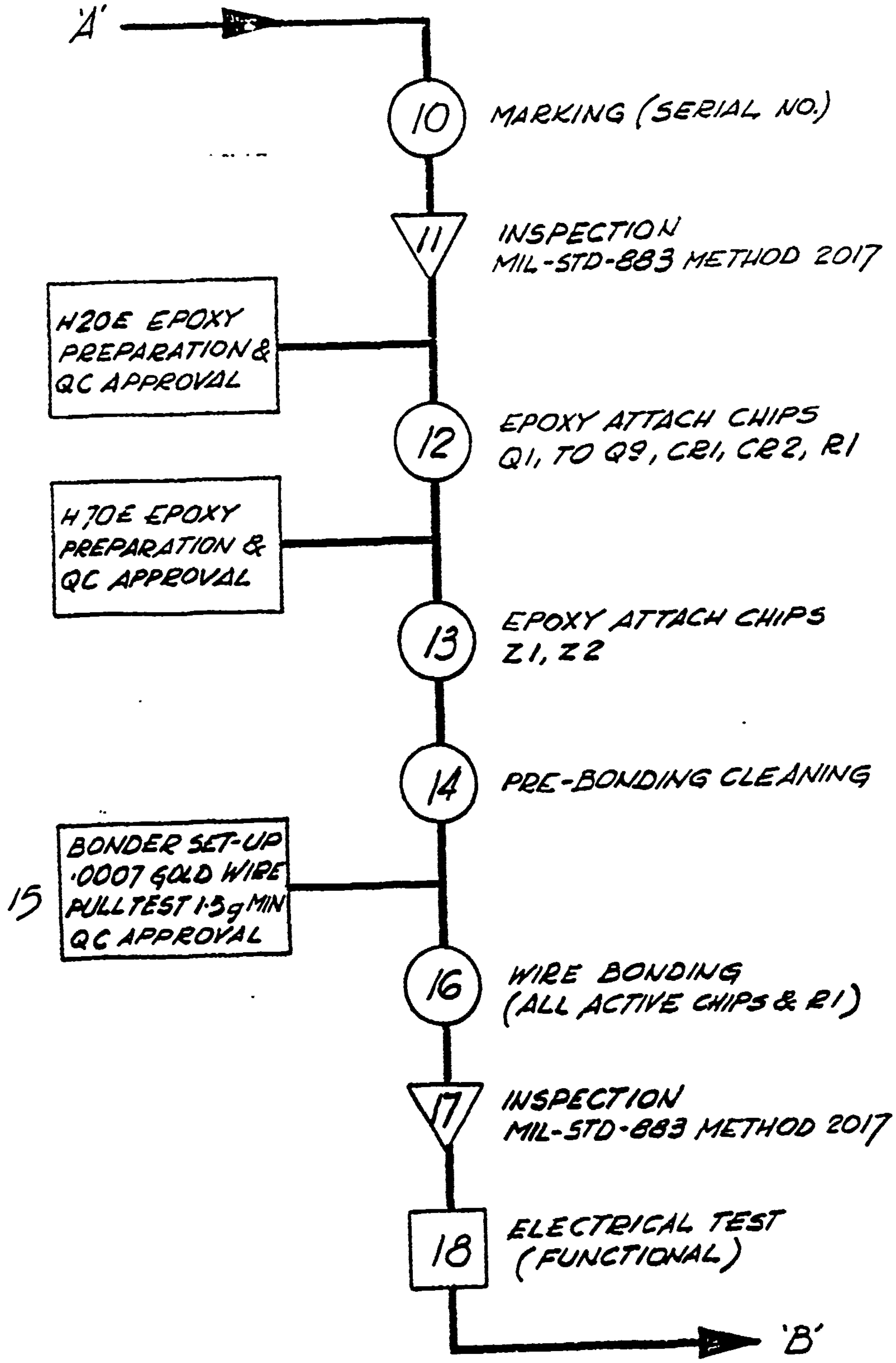
P6046

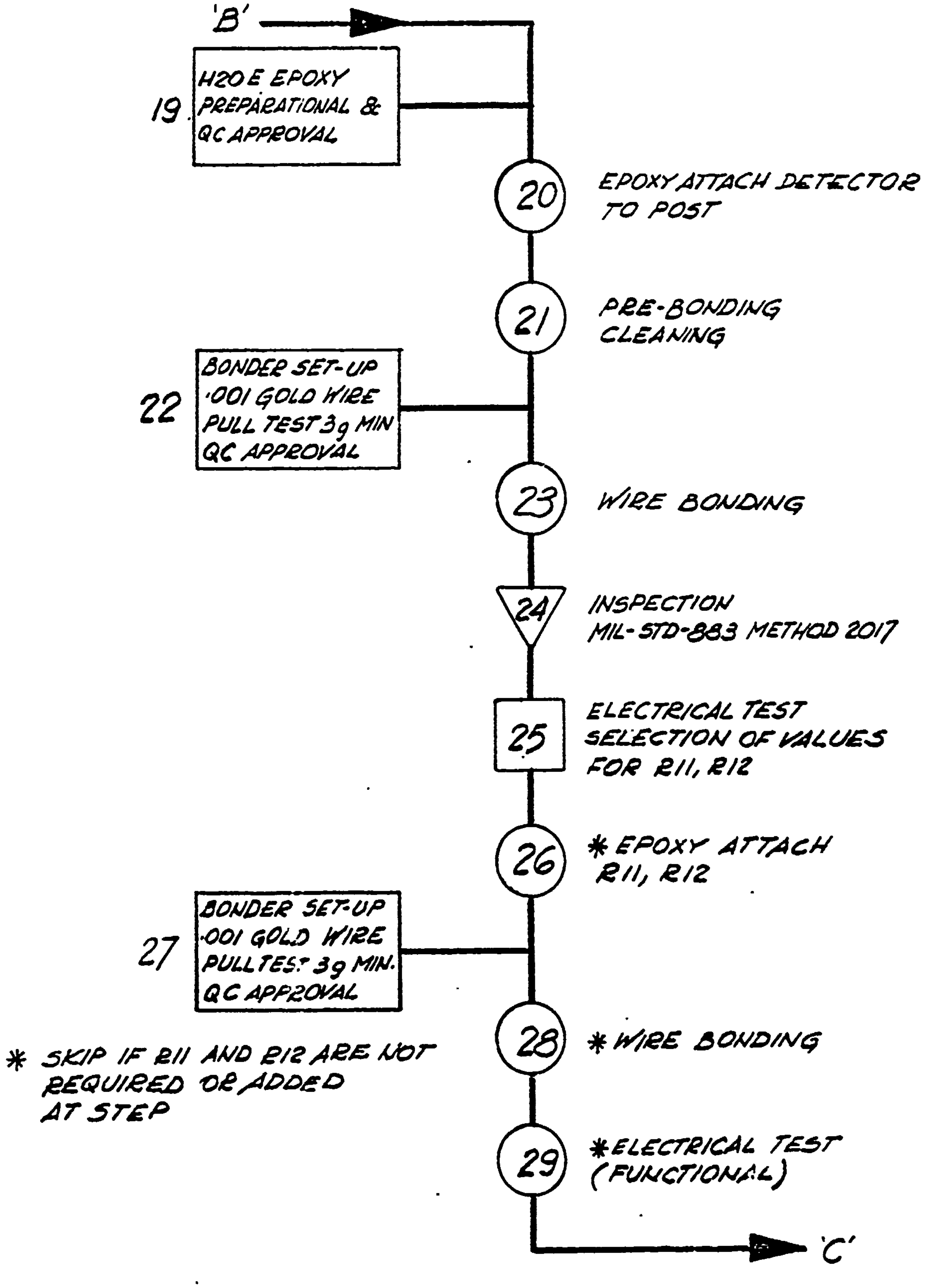


A SIZE P6046 REV. 0

RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

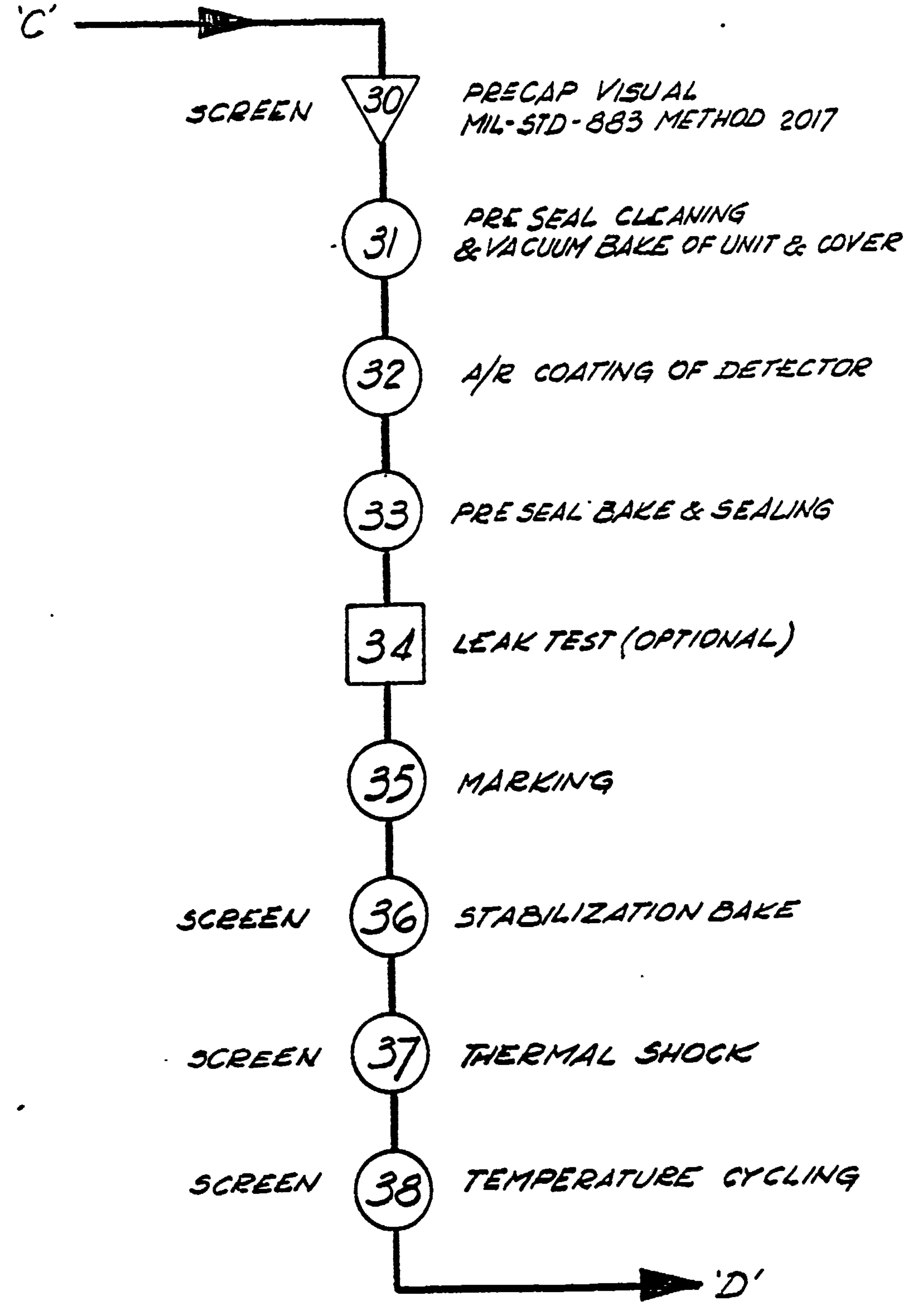
P 6046




'B'
19 H20E EPOXY PREPARATIONAL & QC APPROVAL
20 EPOXY ATTACH DETECTOR TO POST
21 PRE-BONDING CLEANING
22 BONDER SET-UP ·001 GOLD WIRE PULL TEST 3g MIN QC APPROVAL
23 WIRE BONDING
24 INSPECTION MIL-STD-883 METHOD 2017
25 ELECTRICAL TEST SELECTION OF VALUES FOR R11, R12
26 * EPOXY ATTACH R11, R12
27 BONDER SET-UP ·001 GOLD WIRE PULL TEST 3g MIN. QC APPROVAL
28 * WIRE BONDING
29 * ELECTRICAL TEST (FUNCTIONAL)
'C'
* SKIP IF R11 AND R12 ARE NOT REQUIRED OR ADDED AT STEP

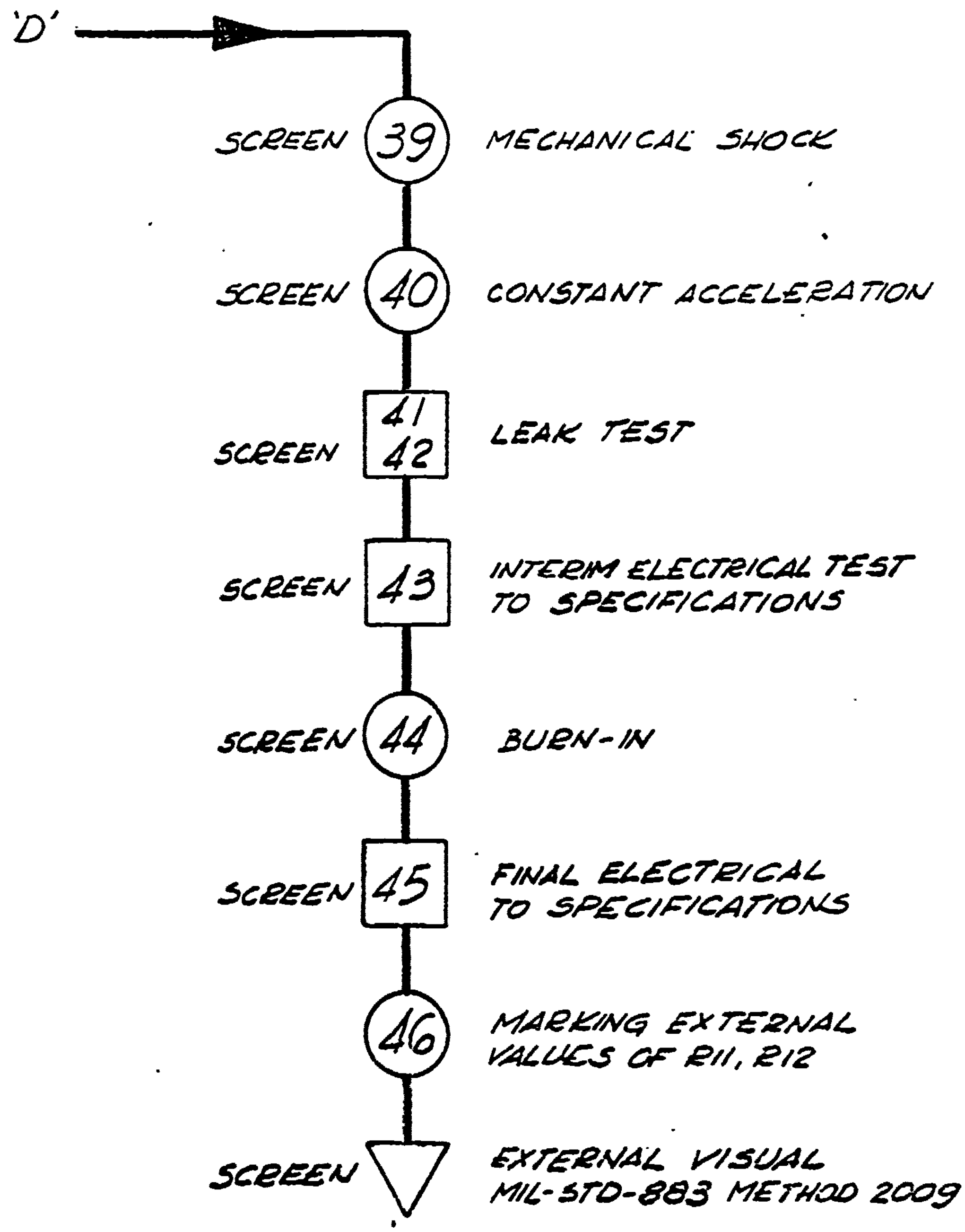
RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

P 6046



RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

P6046



A SIZE P6046 REV. 0

CODE IDENT NO 95311 | SHEET 5 CONT'D ON SH FIN

FLOW CHART

A (SIZE)	P6047
CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

RCA — RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

COMPILED BY	CHECKED BY
R.E. CARDINAL	R.S. Cardinal 79-5-28

CRIPTION

SAPDM-1(C30944E) ASSEMBLY

FIRST MADE FOR	GRP.
E08D/SSD	
C30944E	

CONT.

REVISIONS

AP. BY	R.S. Cardinal	0
DATE	79-5-28	X

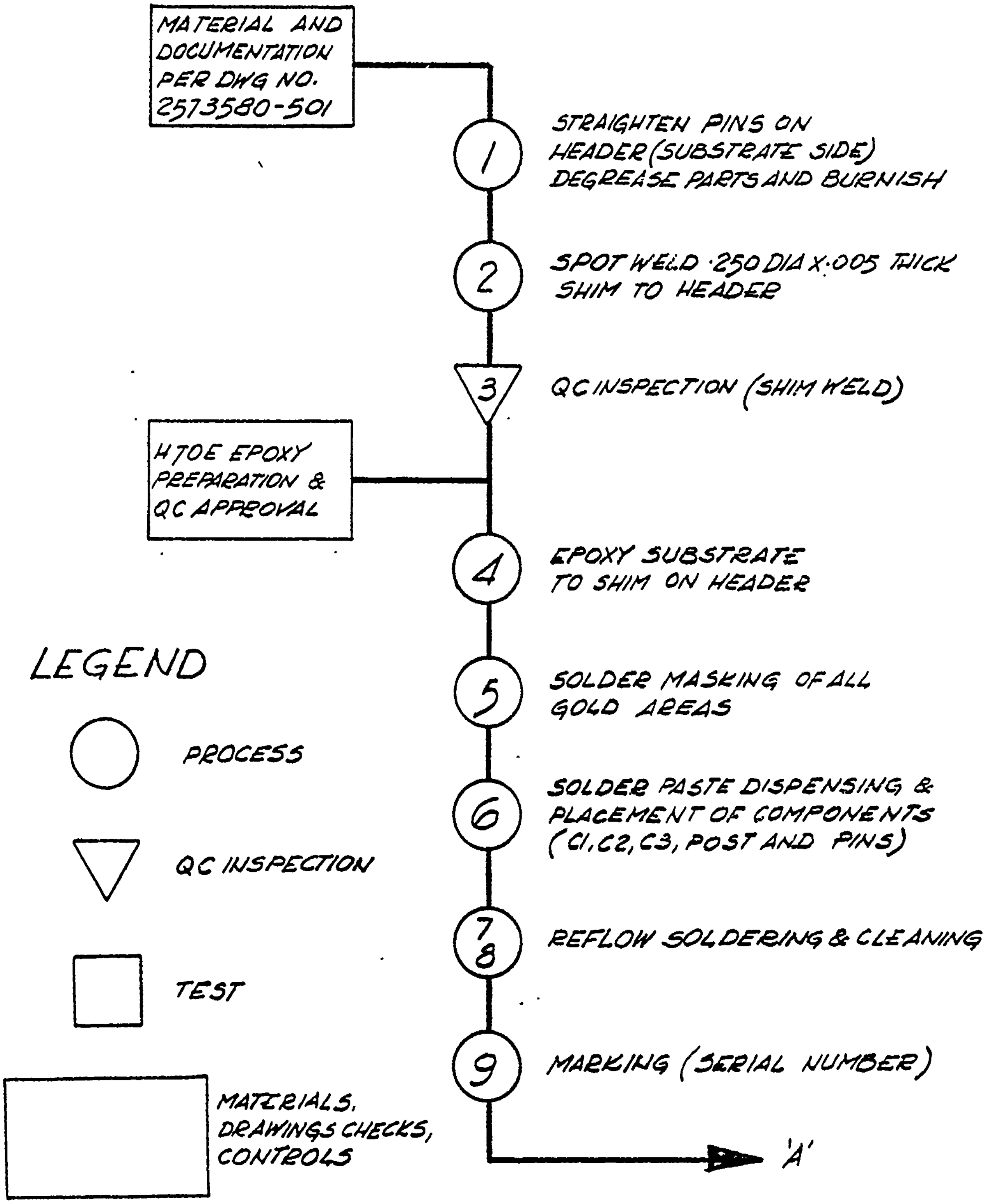
THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

4226-1/71

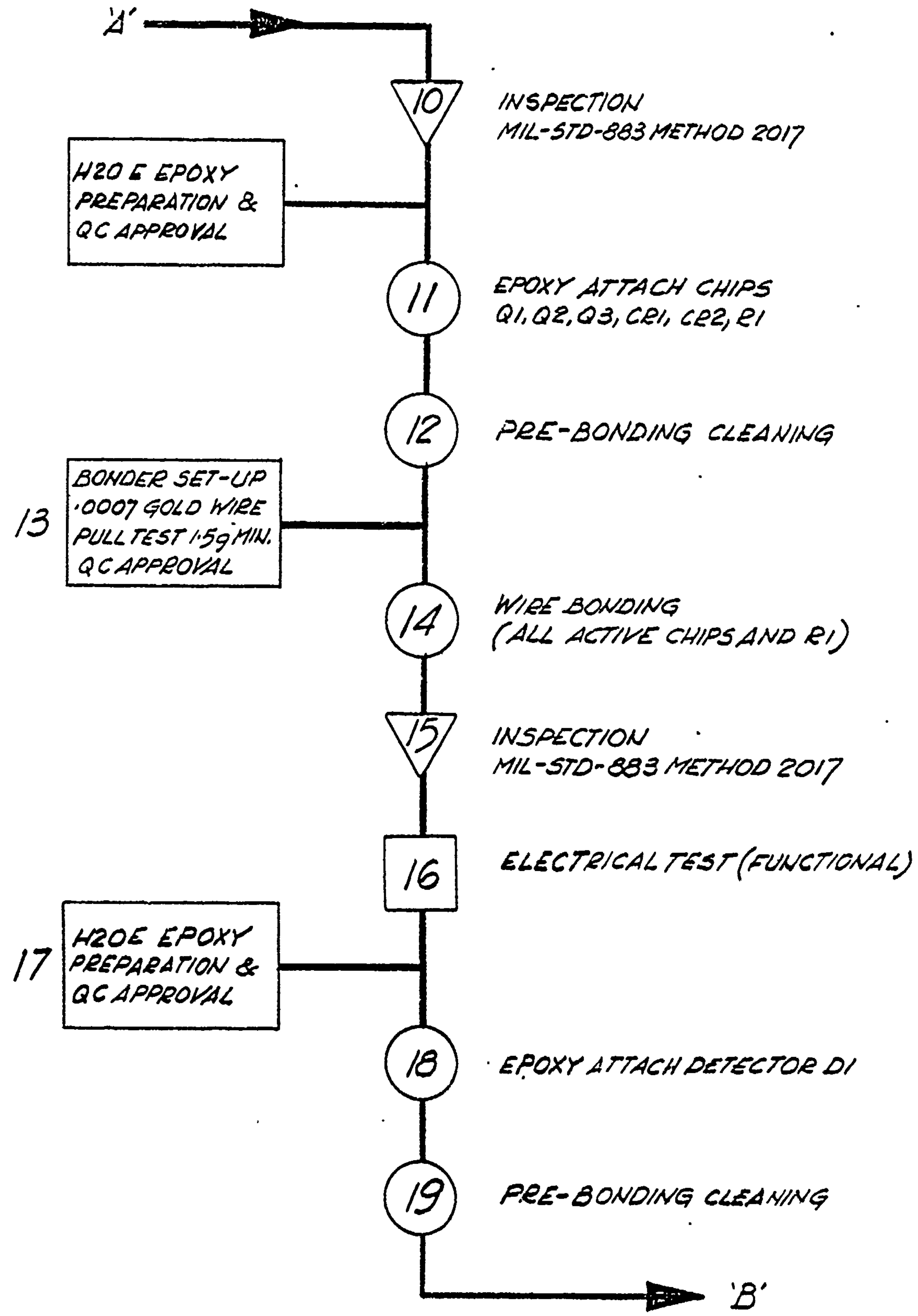
RCA LIMITED
STE. ANNE DE BELLEVUE, QUÉBEC

P6047



A SIZE	P6047	REV. 0
CODE IDENT NO 95311	SHEET 1	CONT'D ON SH 2

RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC
P6047

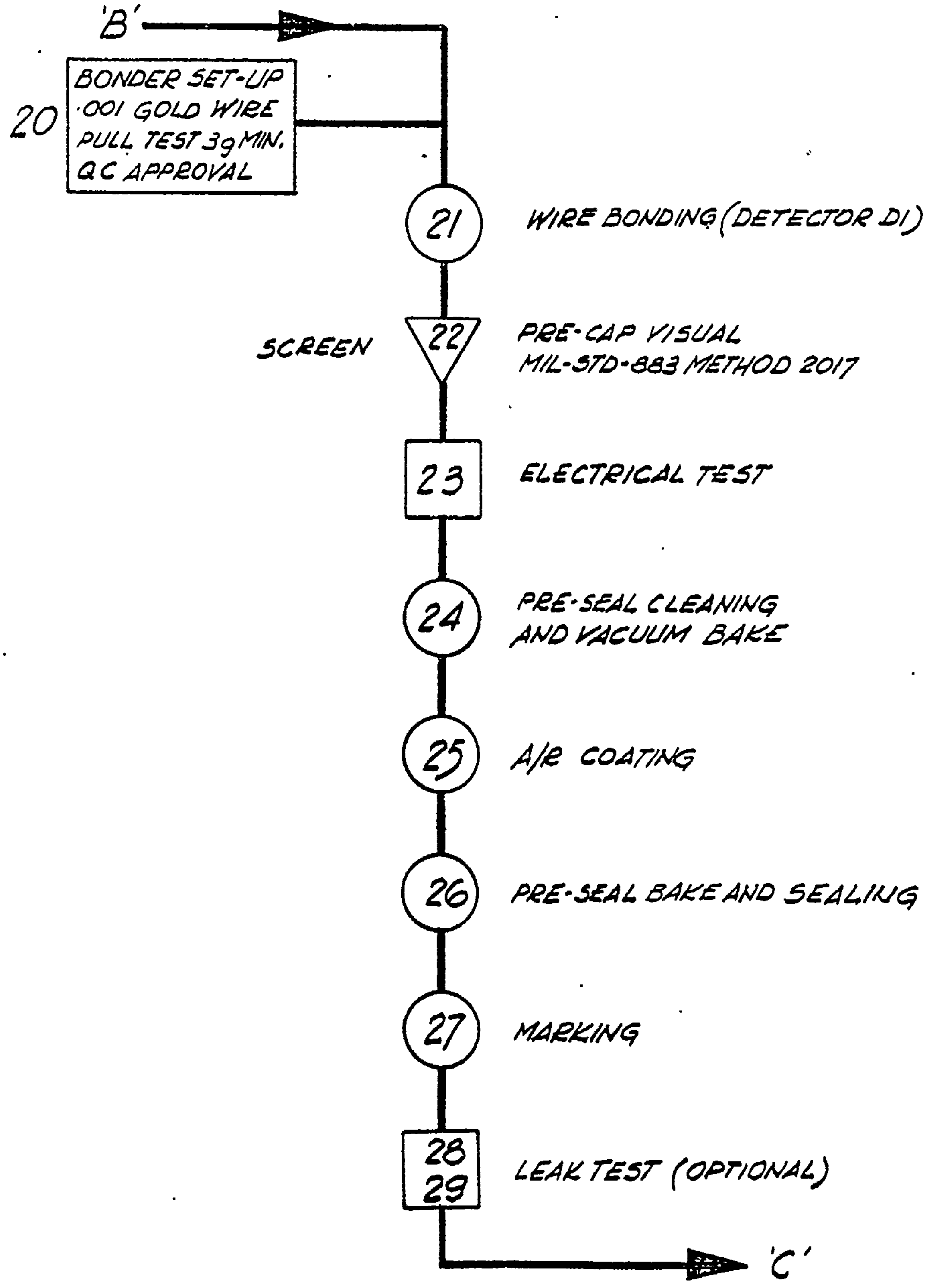


A SIZE | P6047 | REV. 0

CODE IDENT NO 95311 | SHEET 2 | CONT'D ON SH 3

RCA RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

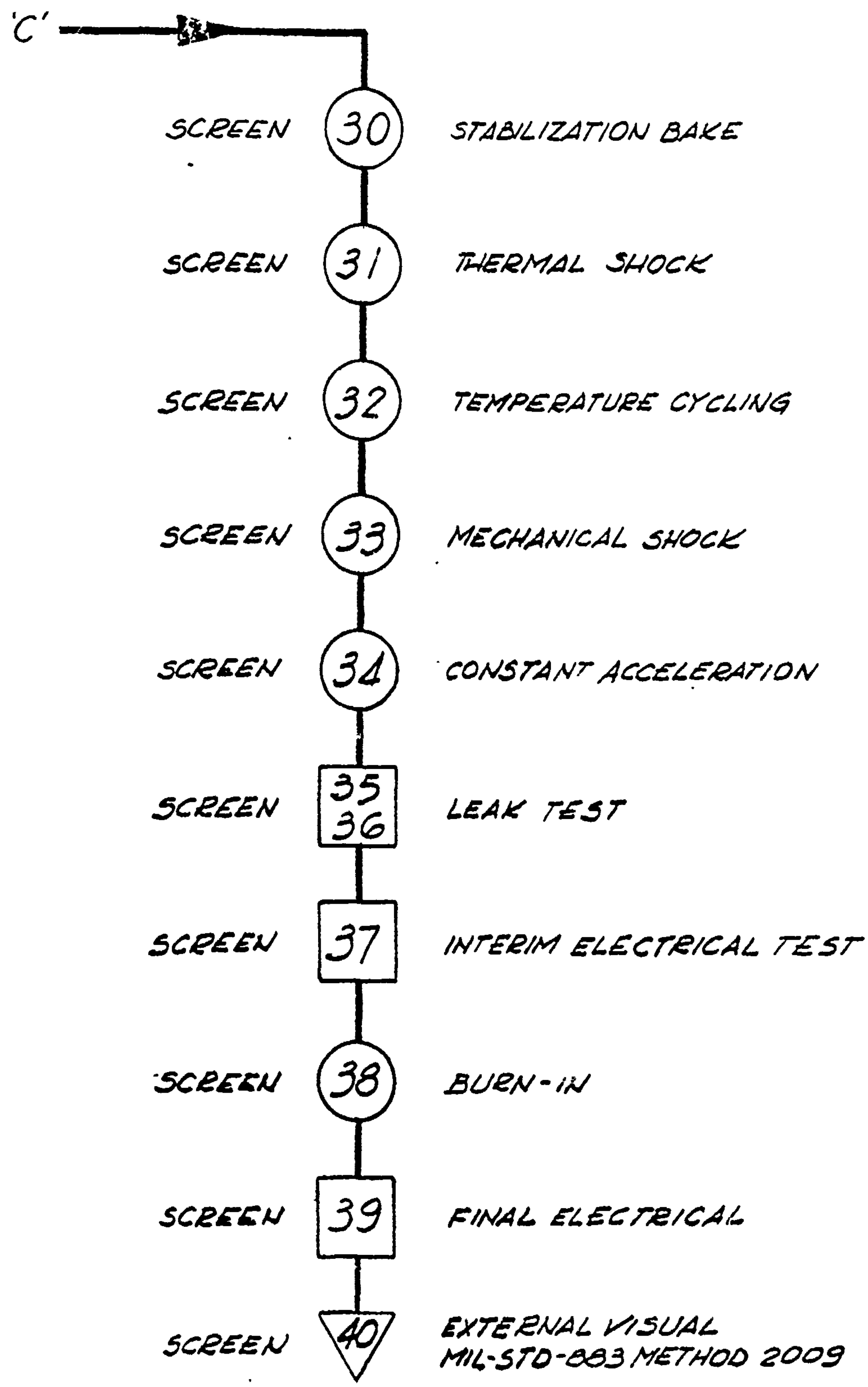
P6047



A SIZE P6047 REV. 0

CODE IDENT NO. 95311 | SHEET 3 CONT'D ON SH 4

RCA RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC
P6047



A SIZE	P6047	REV. 0
CODE IDENT NO 95311	SHEET 4	CONT'D ON SH FIN

PROCEDURE

A SIZE	P4008
CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

RCA RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

COMPILED BY	CHECKED BY
A. STRYCHALSKI	79-4-30

DESCRIPTION

PRESEAL BAKE

FIRST MADE FOR	GRP.
EO&D/SSD	

CONT

REVISIONS

AP. BY H.L. SPRIGINGS	0
DATE DEC 72	
REVISED AS PER ECN 0320 W. RUTA 79-4-18	
R. L. Cardin 79-6-6	1x

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

238

4226-1/71

I. PURPOSE

This procedure describes an approved method for baking assembled packages prior to sealing in order to minimize moisture and other volatile impurities in the enclosed atmosphere.

II. PARTS

A. Metal carrier trays.

III. MATERIALS

A. Workpieces ready for sealing.
B. Package covers.

IV. EQUIPMENT

A. Vacuum oven - Fisher or National.
B. Alcatel vacuum pump or equivalent.

V. SAFETY PROCEDURES

Use heat protective gloves when transferring units from hot oven.

VI. PREPARATION

A. Normal layout of work, tools and material.
B. Confirm that temperature of vacuum oven is in the range 115° - 125°C.

VII. PROCEDURE

A. Place package and lids in metal trays.
B. Place trays in vacuum oven 120° $\pm$ 5 °C.
C. Close exhaust valve.
D. Open vacuum valve.
E. Turn on vacuum pump, and hold door closed until suction keeps the door closed.
F. When vacuum gauge reaches 27 inches or more, close vacuum valve and shut off vacuum pump. Both exhaust and vacuum valves should now be closed.
G. Bake units for one (1) hour minimum at 120°C $\pm$ 5°C.
H. When units are ready to be encapsulated, open exhaust valve and door.

CAUTION: UNITS ARE VERY HOT!

I. Use heat protective gloves to transfer trays from vacuum oven to the encapsulating oven.
J. Close door on vacuum oven and repeat exhaust cycle. The oven should be kept under vacuum until the next bake cycle

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VIII. MAINTENANCE

PROCEDURE

A (SIZE)	P4010
CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

COMPILED BY A. STRYCHALSKI | CHECKED BY [illegible] 79-4-30

RCA — RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

ENCAPSULATION

FIRST MADE FOR	GRP.
EO&D/SSD	

CONT.

REVISIONS

AP. BY H.L. SPRIGINS	0
DATE	
REVISED AS PER ECN 0319 W. RUTA 79-4-17	
[illegible] 79-6-6	1x

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

4226-1/71

I. PURPOSE

To hermetically seal window cap on detector base assembly.

II. PARTS

A. Detector base assembly (or header).
B. Window cap.
C. Practice headers and caps.

III. MATERIALS

A. Dry nitrogen.
B. Compressed air.
C. Helium.

IV. EQUIPMENT

A. Welder (Thompson).
B. Vacuum pump (Millipore).
C. Illuminators.
D. Stainless steel tweezers.
E. Electrodes (matched set).
F. Oven (Fisher).
G. Microscope (American Optical), 10X, 20X.
H. Nitrogen gun.

V. SAFETY PRECAUTIONS

A. Never make adjustments to equipment while power is on.

B. Weld switch must be in no-weld position unless actual welding is to take place.

C. CAUTION: when welding or tip-dressing, keep hands away from electrodes.

VI. PREPARATIONS

A. Caps and base assemblies should be cleaned according to processes P4009 and P4008.

B. Open compressed air valve.

VI. PREPARATIONS

C. Adjust following settings according to TABLE I for the appropriate device package type:

1. Both air-line pressure regulators.
2. Top pressure regulator.
3. Both transformer settings.
4. Number (1 or 2) of rectifier tubes connected. (If only 1 is needed, disconnect the one on the left by removing top connector cap), only when power is off.
5. Add. setting.
6. Weld setting.
7. Heat control setting.
8. Squeeze setting.
9. Hold setting.
10. Off setting.

D. On lower panel, switch must be in single stroke position.

E. Screw in desired set of electrodes (according to package type) and tighten firmly using tightening rod. Replace teflon strips over holes to achieve greater vacuum.

NOTE: Electrodes are precision-made and should be handled with extreme care to prevent damaging them.

F. Switch on Millipore vacuum to maximum setting and turn on illuminators.

G. Turn on nitrogen gas cylinder and set flow rate to approximately 10 C.F.H.

NOTE: Nitrogen gas is used in the set up for TO-18 and TO-5 packages unless otherwise noted on the assembly batch sheets.

For packages larger than TO-5, use helium for the set up.

H. Adjust nitrogen nozzle for specific height of device. (For maximum performance, slot should be set to line up with the surface of the base or header).

I. Switch on main power circuit breaker.

J. Press tip-dress switch and examine to see that both electrodes come together properly.

K. Maintenance technician or supervisor should insure that all settings are properly adjusted for particular package to be welded.

VII. PROCEDURE

A. Turn weld/no-weld switch to weld position.

B. Wearing clean finger cots, remove practice header (or base assembly) from oven.

C. Using nitrogen gun, gently blow off any dust or loose particulate matter from surface.

D. Place practice header (or base assembly) in proper position in lower electrode.

E. Wearing clean finger cots, remove practice window (or cap) from oven.

F. Using nitrogen gun, blow off any dust or loose particulate matter from inside surface of cap and then inspect under microscope (X20) to see that window is perflectly clean. See supervisor if in doubt.

G. Place clean practice window on a clean metal slide.

H. Depress vacuum foot switch (do not release until device is welded).

I. Hold practice window under upper electrode and allow vacuum to "suck" window into position. (Examine to see that it is sitting properly.)

J. Press both side micro-switches simultaneously to achieve welding.

K. Remove package from electrodes.

L. Present package to Q.C. for approval of seal. For packages sealed with helium, fine and gross leak tests will be performed by Q.C.

M. Upon endorsement of the weld seal from Q.C., proceed to weld remaining packages with nitrogen gas.

N. Record weld settings as per Table II in Log under device type or electrode number. Q.C. approval stamp is required for all set-ups.

O. To shut down machine, follow these steps:

1. Turn weld/no-weld switch to no-weld position.
2. Shut off main power switch on wall.
3. Shut off illuminators and vacuum pump.
4. Unscrew electrodes and place in original container.
5. Shut off nitrogen gas cylinder.
6. Shut off compressed air supply.

VIII. MAINTENANCE

See Maintenance technician.

IX. INSPECTION

A. Visually inspect first sample welds under 20X microscope.

B. Leak test units per sampling schedule.

C. Report any deviation to your supervisor.

D. Record results on batch sheet.

ELECTRODE DRAWING NO: 1829960 SET #

Use on Unit Type: C ________________ Header P/N

________________ Cover P/N

Initial Setting Suggested:

Transformer: Top Pressure: Tubes:

Air Line Pressure: Weldsetting: Heat Control:

Rework Electrode Faces After ________________ Seals.

Date	Oper.	Batch No.	Qty	Cum. Total	SETTING USED						Approval Set-Up
					Tra	Air Line	Top Pres	Weld	Tube	Heat	

TABLE II

TABLE I
TYPICAL WELD SCHEDULES

PACKAGE TYPE OR DRAWING NO.	DEVICE TYPE	NUMBER OF TUBES	TRANSFORMER SETTINGS		AIR LINE PRESSURE	TOP PRESSURE	WELD SETTING	HEAT CONTROL SETTING	RESURFACE AFTER WELD	NOTES
			Tap 1	Tap 2						
TO-18	C30807 C30902E C30920E C30921E C30922E	1	1	-	12	0	-	28	200	Disconnect one tube
TO-5	C30801 C30802 C30808 C30808A C30812 C30815 C30817 C30843 C30884 C30924E	1	1	1	22 - 30	10	1	30	300	
To-8	C30809	2	5	5	40	22	1	42	200	
	C30818	2	5	5	12	30	1	40	300	
	C30821	2	5	5	12	30	1	40	300	
	C30822	2	5	5	40	22	1	42	200	

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TABLE I (Continued)

TYPICAL WELD SCHEDULES

PACKAGE TYPE OR DRAWING NO.	DEVICE TYPE	NUMBER OF TUBES	TRANSFORMER SETTINGS		AIR LINE PRESSURE	TOP PRESSURE	WELD SETTING	HEAT CONTROL SETTING	RESURFACE AFTER WELD	NOTES
			Tap 1	Tap 2						
TO-8	C30872	2	5	5	40	12	1	42	300	
	C30899	2	5	5	40	12	1	42	300	
	C30904E	2	5	5	40	12	1	42	300	
	C30930E	2	5	5	30	12	1	40	300	
CUSTOM										
2573544	C30805	2	7	7	40	30	2	40		
2529925	C30810	2	7	7	54	38	5	52	50	
1825781	C30810B	2	7	7	60	28	2	48	-	
2529944	C30824	2	7	7	54	38	5	52	100	
2529944	C30825	2	7	7	54	38	5	52	100	
2573544	C30846	2	7	7	40	30	1	54	-	
2529925	C30854	2	7	7	40	30	2	64		
2555645	C30859	2	7	7	60	28	2	48	75	
1829983 1829983	C30882 C30883	2	5	5	35	20	1	38		
2542596	C30896	2	7	7	60	45	6	70	25	

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TABLE 1 (Continued)

TYPICAL WELD SCHEDULES

PACKAGE TYPE OR DRAWING NO.	DEVICE TYPE	NUMBER OF TUBES	TRANSFORMER SETTINGS		AIR LINE PRESSURE	TOP PRESSURE	WELD SETTING	HEAT CONTROL SETTING	RESURFACE AFTER WELD	NOTES
			Tap 1	Tap 2						
CUSTOM 2580051	C30937 C30947	2	7	7	69	57	3	52	-	
	SCS469	2	7	7	60	15	2	45	-	
	DREV	2	7	7	40	30	2	50	-	

4219A-1/71

PROCEDURE

A SIZE | P4027

CODE IDENT NO. 95311 | SHEET 0 CONT'D ON SH 1

COMPILED BY J. BIGNET

CHECKED BY A.S. 794-30

RCA — RCA LIMITED, STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

REFLOW SOLDERING

FIRST MADE FOR	GRP.
C30899	

CONT.

REVISIONS

AP. BY	R. L. Laidlaw	0
DATE	29-6-6	x

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

1. APPARATUS AND MATERIALS

1.1 Linear reflow soldering system Browne Model LR-6

1.2 Strong pliers

1.3 Q-tips (single ended)

1.4 Tweezers

1.5 Isopropyl alcohol. RCA P/N 882116-32

1.6 Kester 5240 flux remover.

2. PREPARATION

2.1 Parts to be assembled shall be prepared according to procedure No. P4047 (Paste Hand Dispensing).

3. EQUIPMENT PREPARATION FOR 60/40 SOLDER PASTE

3.1 Start reflow system approximately 15 minutes before its intended use.

3.1.1 Depress Master Start - (Red light should come on)

3.1.2 Switch On - Power of preheat and reflow zones.

3.1.3 Switch on Exhaust Fan - Cooling Blower - Belt Motor. (Pilot lights should come on).

3.1.4 Exhaust Intensity on 100.

3.2 Adjust belt speed to 0.40 initially. (to be corrected in 4.1 to 4.5).

3.3 Adjust reflow temperatures to 250°C and preheat temperature to 220°C.

3.4 The system is ready when the light on the temperature control, switches from red to green.

4. SET-UP AND OPERATION FOR 60/40 SOLDER PASTE

4.1 Apply a small amount of solder paste onto a carrier or circuit, similar to the one to be used, as per Drawing 2505309.

4.2 Observe how far from the end of the reflow zone the solder melts.

4.3 Melting should occur at about 2 inches from the end of the reflow zone.

4.4 If melting occurs too soon: increase belt speed.

4.5 If melting occurs too late: decrease belt speed.

4.6 If necessary repeat 4.1 and 4.2 using a cold carrier until 4.3 is met.

4.7 Do not operate reflow system at temperatures below 230°C nor above 380°C without specific instructions from supervisor.

4.8 Belt speed should not be reduced below 0.30 without specific instructions.

4.9 Never place a carrier over the belt junction.

4.10 Start carriers at the beginning of the belt (near the loading station).

4.11 Once criterion set at 4.3 is met, all identical carriers can be processed.

4.12 When solder paste is fully melted, move the substrates back and forth to eliminate flux pockets and to insure good wetting. (Use wooden end of Q-tips if necessary for MIC).

4.13 Using tweezers and Q-tip reposition components and substrate carefully if necessary BEFORE carrier leaves the reflow zone. (Stop belt for a short time if necessary).

4.14 When a carrier or circuit reaches the end of the belt dip it in a bath of (Kester 5240) flux remover for a superficial cleaning of the flux.

4.15 Check solder joint to meet criteria of section 5 at the beginning of operation.

4.16 Fill batch sheet and indicate belt speed, preheat and reflow temperatures.

5. VISUAL CRITERIA

5.1 Visible solder should be smooth and shiny. (no granular appearance).

5.2 All solder fillets shall show evidence of wetting at both the chip bond area and at the substrate bond pad.

5.3 If problems arise concerning the visual criteria - call supervisor.

6. SAFETY PRECAUTIONS

6.1 Observe solvent handling precautions with Kester solvent.

PROCEDURE

A SIZE	P4028

CODE IDENT NO 95311 | SHEET 0 CONT'D ON SH 1

RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

COMPILED BY J. BICKET / M. FOSSIEZ

CHECKED BY M. FOSSIEZ

DESCRIPTION

MARKING

FIRST MADE FOR	GRP.
C30899	

REVISIONS

AP. BY	V.S. [illegible]	0
DATE	77-2-17	

NEXT ASS'Y.

1. HAND MARKING

1.1 Equipment and Material

1.1.1 Glass Slide

1.1.2 Rubber roler

1.1.3 Rubber stamp

1.1.4 Wornow Series R one component ink

1.1.5 Methanol

1.1.6 Q-tips

1.2 Operation

1.2.1 Apply small amount of ink on glass slide

1.2.2 Spread ink using roller to have thin film of ink

1.2.3 Clean base using methanol

1.2.4 Take stamp and wet with ink

1.2.5 Make a first print on glass slide and the second one on base

1.2.6 Cure printed parts for 1 hour at 150°C in N_2 oven

1.2.7 Clean rubber stamp when operations are finish using methanol

1.2.8 Fill in batch sheet

2. MACHINE MARKING

2.1 Equipment and Material

2.2.1 JAN TECH Model 105 Marking Machine

2.2.2 Wornow series R one component ink

2.2.3 Solvent T-1 for series R ink

2.2.4 Glass slide

2.2.5 Spatula

2.2.6 Cleaning mixture solvent.(Toluene, M.I. B.K., Ethylene Glycol, Cellosolve Acetate; 1 part of each)

2.

2.1

2.2.7 Q- Tips

2.2.8 Kimwipes disposable wipers

3. USE OF CLEANING SOLVENT

3.1 The solvent must be used sparingly. It must be kept in a bottle to prevent evaporation.

3.2 The Toluene, M.I. B.K. Ethylene Glycol, Cellosolve Acetate mixture can be used to clean ink off any part of the machine. It can be used to remove a defective marking "before" the baking operation takes place.

3.3 The machine should be cleaned at the end of a printing session or at the end of the work period.

4. OPERATION OFF-SET PRINTING

4.1 Mount the die on the marking machine

4.2 Cut the transfer rubber to match the part to be printed

4.3 Mount the rubber pad on the printing table using double faced adhesive.

4.4 Adjust the printing table so the die barely touches the rubber pad

4.5 Apply the printing ink to the roller using a glass slide

4.6 Ink the die by operating the machine with the jog switch. Ink several times to have a neat imprint on the pad.

4.7 Switch the machine on and use the foot switch for production

4.8 Start printing with set-up parts until results are satisfactory (make sure the imprint meets the specification of the drawing).

4.9 Clean the pad and the die with a Q-tip wetted with solvent as soon as the print gets blured.

4.10 When results are satisfactory start production.

4.11 Fill in batch sheet

4.12 Clean Machine

PROCEDURE

SIZE	A
	P 4029
CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

COMPILED BY	CHECKED BY
J. BIGNET	77-3-28 J. Biguet 77-12-19

RCA — RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

PASTE HAND DISPENSING (SOLDER)

FIRST MADE FOR	GRP.
EO&D/SSD	
C30899	

CONT.

REVISIONS

AP. BY R. S. Cardinal	0
DATE 77-12-20	x
REVISED AS PER ECN 0315 W. RUTA 79-4-16	
R. S. Cardinal 79-6-6	1x

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

4226-1/71

257

I. APPARATUS

1.1 Automatic paste dispenser Laurier Associates Inc., Model M101 or equivalent.

1.2 Manual paste dispenser.

1.3 Syringe 3cc or 5cc.

1.4 Needle CAMMDA (Green #18, Blue #22, Pink #20).

1.5 Beakers or Pyrex ware (size to match parts).

1.6 Carrier (size to match parts).

1.7 Brushes.

1.8 Spatula.

II. MATERIALS

2.1 Shipley Co. Inc., NC68.

2.2 D.I. water (>10 Megohms).

2.3 Alcohol (Methanol EG).

2.4 Solder Paste Kester "Rheomet" Code 61203 62 SN-36Pb-2Ag (for MIC).

2.5 Alpha RMA332 85C-50 62Sn-36Pb-2Ag (for Hybrid).

2.6 Lancer RR458.

III. PREPARATION (MIC ONLY)

3.1 Prepare NC68 solution: 1 part D.I. Water, 2 parts NC68.

3.2 Immerse carrier with parts in NC68 at room temperature for 5 minutes with agitation.

3.3 Rinse 2 minutes under running D.I. water.

3.4 Rinse in Alcohol 1 minute.

3.5 Dry 3 minutes in Nitrogen spin dryer - Do not spin.

3.6 Check a few circuits. -If objectionable stains remain after cleaning report to supervisor.

3.7 Discard solution if pH is not between 6 and 8.5 (Use pH paper).

IV. SEQUENCE OF OPERATIONS

4.1 Apply protective coating.

4.2 Apply solder paste on carrier.

4.3 Apply solder paste to the back of the circuit.

4.4 Apply solder paste to the front of the circuit if specified on batch sheet instructions. (Use the appropriate tool for this operation).

V. PROTECTIVE COATING

5.1 Paint portion of circuit to be protected, with Lancer RR458 using brush or needle.

5.2 Dry in air at room temperature.

VI. PREPARATION FOR PASTING

6.1 Stir solder paste with spatula to get a homogeneous composition.

6.2 Fill syringe with paste.

6.3 Open air valve (for LM101 set switch on Manual and power on). Set pressure to match the work.

6.4 Mount appropriate needle if required.

6.5 Depress foot pedal until paste flows smoothly out of syringe.

VII. SOLDER PASTE DISPENSING

7.1 Solder paste on carrier (MIC only).

7.1.1 Dispenser Manual, determine the amount of solder paste required for the parts to be assembled.

7.1.2 For LM101 in automatic operation:

7.1.2.1 Switch to Automatic.

7.1.2.2 Determine time setting required to get an equivalent amount of paste as determined at 7.1.1.

7.1.2.3 If time is too short for consistant results, reduce air pressure or use a smaller needle.

7.1.2.4 Wide surfaces will not be covered with a single cycle. Use as many cycles as necessary.

7.1.3 Apply the paste.

7.1.4 Spread evenly with a brush.

7.2 Solder paste to the back of substrate (MIC only).

7.2.1 With the brush used in 7.1.4 moisten evenly the back with as little as possible of paste.

7.2.2 Place substrate on carrier.

7.3 Solder paste to the top of circuit.

7.3.1 Proceed as per 7.1.2.1 to 7.1.2.4.

7.3.2 Apply paste on each pad where it is required.

7.3.3 Apply components in the paste as per applicable assembly drawing.

7.3.4 Using a needle, insure a good wetting of the capacitors if necessary.

7.4 At the end of the day return left over paste to the container.

7.5 Fill in batch sheet.

VIII. SPECIAL CONSIDERATIONS

8.1 Paste dispensing requires judgement, initiative and care.

8.2 The operator should be well informed of the final requirements and of the inspection criteria.

IX. SAFETY PRECAUTIONS

9.1 Solvent materials used can cause skin irritation. DO NOT ALLOW TO COME IN CONTACT WITH SKIN OR EYES. Use appropriate protection for hands and fingers.

9.2 If material comes in contact with skin wash it off immediately with soap and water until it all has been removed. In the event of eye contact flush immediately with water and obtain medical attention.

PROCEDURE

A SIZE	P 4032
CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

COMPILED BY J. BIGNET

CHECKED BY 79-4-20

RCA RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

EPOXY CHIP MOUNTING PROCEDURE

FIRST MADE FOR	GRP.
EO&D/SSD	

CONT

REVISIONS

AP. BY R.E. CARDINAL	0
DATE 76-5-28	
REVISED AS PER ECN 0330 W. RUTA 79-4-20	
79-6-6	1x

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

I MATERIALS AND APPARATUS

1.1 Epoxies: Epoxy Technology, H20E, H70E.

1.2 Scale Sartorius Model #1106.

1.3 Glass slides.

1.4 Disposable weight boats.

1.5 Micro spatula.

1.6 West-Bond model 7200 die-bonder/Laurier SA202.

1.7 Cartridge (Dispense tool) West-Bond.

1.8 Vacuum pick-up needles Gaiser.

1.9 Free anvil work holder.

1.10 Vacuum pump.

1.11 Fisher vacuum oven set to $120^{o}C \pm 5^{o}C$.

1.12 Thermolyne oven set to $80^{o}C \pm 5^{o}C$.

II EPOXY PREPARATION

2.1 Turn on the scale.

2.2 Check scale levelling (bubble indicator), correct if necessary.

2.3 Check scale zero.

2.4 Place a weighing boat on the plate.

2.5 Use the rear knob to replace the indicator to zero.

2.6 Open epoxy part A and mix it vigorously.

2.7 Pour epoxy in the boat (the amount is determined by the work to be done and the mixing ratio of part A and B).

2.8 Repeat 2.5.

2.9 Proceed as per 2.6 and 2.7 with epoxy part B.

2.10 Mix the two parts for at least 1 minute with a spatula

2.11 Always wear plastic gloves when mixing epoxy.

III SAFETY PRECAUTIONS

3.1 Epoxies can cause skin irritation. DO NOT ALLOW EPOXY TO COME IN CONTACT WITH SKIN OR EYES. Use appropriate protection for hands and fingers.

3.2 If epoxy comes in contact with skin wash it off immediately with soap and water until all epoxy has been removed. In the event of eye contact flush immediately with water and obtain medical attention.

IV EPOXY QUALIFICATION

4.1 For each job to be done or if a job is left for more than 3 hours, a test sample must be made.

4.2 Apply a small amount of the mixed epoxy to be used on a glass slide.

4.3 Identify glass slide with the batch sheet number.

4.4 Cure at 120°C ± 5°C for 20 minutes.

4.5 After curing check for hardness; if any doubt about the epoxy (colour, grain size, hardness) call supervisor.

4.6 Never start the work until this test has been done successfully.

4.7 Submit sample and batch sheet to QC for approval.

V WEST BOND MACHINE

5.1 West Bond preparation

5.1.1 Fill in cartridge with a sufficient amount of mixed epoxy. A convenient way to do this is as follows:

5.1.1.1 Fill in, with spatula, a disposable syringe with mixed epoxy.

5.1.1.2 Put piston in the syringe and push down epoxy.

5.1.1.3 Transfer epoxy to the West Bond cartridge.

5.1.1.4 Put cap onto the cartridge.

5.1.2 Place appropriate size West Bond needle on the cartridge. (The size is a function on the amount of epoxy required for the job).

5.1.3 Secure assembly in the arm and connect the air line.

5.1.4 Check that vacuum pick up tool is of the appropriate size; if not, change it.

5.1.5 Check sensing needle behind epoxy needle; the sensing needle must be lower than the dispensing needle.

V WEST BOND MACHINE

5.2 OPERATION

5.2.1 Secure down substrate onto appropriate work holder.

5.2.2 Turn on machine: power on, air pressure on: 5 psi, vacuum on, Auto position.

5.2.3 By raising the Z lever, the machine turns from vacuum pick-up position (red light on) to epoxy dispense position (green light on). Get the head on epoxy dispense position.

5.2.4 Lower Z lever onto substrate until you dispense epoxy and reduce or enlarge dot size by adjusting the following:

5.2.4.1 Time Knob.

5.2.4.2 Pressure level.

5.2.4.3 Sensing needle position.

5.2.5 Secure work onto work holder.

5.2.6 If necessary, place chip onto chip holder ring or jig.

5.2.7 Focus microscope onto work.

5.2.8 Apply a dot of epoxy at the first place required, use Z lever for positioning.

5.2.9 Raise Z lever to turn to vacuum pick-up position.

5.2.10 Check white light: if on (light on means the vacuum is connected). Lower the head onto a free space until the light switches off.

5.2.11 Lower the head onto an appropriate chip until the white light comes on.

5.2.12 Bring the chip over the epoxy dot and place it on. The epoxy must be visible along 50% of the chip periphery.

5.2.13 Proceed as per 5.2.8 to 5.2.12. for all the remaining chips.

5.2.14 When the work is completed, put it into the appropriate oven for curing as required by the batch sheet.

5.2.15 Fill in batch sheet.

5.2.16 Clean needle and cartridge using methyl alcohol and ultrasonic bath when pot life of epoxy is expired.

VI LAURIER MACHINE 2A202

6.1 Remove top of rotary epoxy squeeze.

6.2 Deposit epoxy in the bottom plate.

6.3 Replace top on epoxy squeeze and rotate the bottom plate to obtain a uniform layer on the plate.

6.4 Turn on machine and vacuum pump.

6.5 Rotate turret to desired stamp and vacuum pick-up position.

6.6 Push the traverse table to the right and manually align work under the stamp.

6.7 Shift table to the left then align the vacuum pick-up over the stamped position using the two (2) micrometers.

6.8 Using a dummy circuit, make a few sample stampings.

6.8.1 Move the Z lever completely to the right, then apply epoxy to the stamp and release vacuum from the pick-up tool.

6.8.2 Shift the table to the left.

6.8.3 Shift the lever completely to the right then, stamp the epoxy on the circuit. Turn on vacuum for the pick-up tool.

6.8.4 Adjust the position and thickness if necessary.

6.9 Arrange epoxy, Fluoroware tray and circuit in their respective holders.

6.10 Shift table to left then, swing lever to right.

6.11 Move table to the left then align the chips under the vacuum pick-up tool then shift lever to the right.

6.12 Shift table to the right. Slowly lower the chip into the epoxy by moving lever to the right.

6.13 Repeat steps 6.10 to 6.12 until all chips are in place on the circuit.

6.14 Repeat above with another circuit.

6.15 Upon completion of all circuits, cure in oven for time and temperature as stated on batch sheet.

6.16 Fill in batch sheet with requested information.

TITLE	SIZE	
PROCEDURE	A	P4035
	CODE IDENT NO 95311 SHEET 0 CONT'D ON SH 1	

COMPILED BY	CHECKED BY
A. STRYCHALSKI	[signature] 79-4-30

RCA RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

PRE-BONDING CLEANING

FIRST MADE FOR	GRP.
EO&D/SSD	

CONT.

REVISIONS

AP. BY	D.J. Parkinl	0 x
DATE	79-6-6	

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE

NEXT ASS'Y.

267

I APPARATUS

1.1 Methyl Alcohol bench top spray equipment.

1.2 Laminar flow box.

1.3 Ventilation hood in laminar flow box.

1.4 Hot plate.

1.5 Beakers 500 ml.

1.6 Nitrogen line filter Millipore.

1.7 Microscope.

II MATERIALS

2.1 Plastic glove.

2.2 Methyl Alcohol, Baker A.C.S. Reagent Grade or equivalent.

2.3 Dry Nitrogen gas.

2.4 Cellulose wipes.

III PROCEDURE

3.1 For device types C30818, C30899 and similar.

3.1.1 Hold substrate in gloved hand, approximately 0.5 ins. in front of spray nozzle.

3.1.2 Spray Methyl Alcohol at various angles to the substrate for approximately 10 seconds.

3.1.3 Let dry under methyl alcohol warm filtered air.

3.2 For most other types.

3.2.1 Fill two clean beakers with methyl alcohol.

3.2.2 Place on hot plate under fume extractors.

3.2.3 Heat alcohol till it just begins to simmer.

3.2.4 Dip cone shapped cellulose wipe into 1st beaker of alcohol.

3.2.5 Carefully wipe the surface of the diode with the methyl alcohol dipped cellulose wipe. Use microscope.

3.2.6 Dip the device into the first beaker of meths for approximately 5 seconds.

3.2.7 Transfer the device to the second beaker of meths for the same time.

3.2.8 Remove from the alcohol and blow dry device with filtered dry nitrogen.

IV CLEANLINESS CRITERIA

4.1 No visible water marks on substrate

4.2 No flux residue on substrate.

PROCEDURE

A SIZE	P4036
CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

RCA RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

COMPILED BY	CHECKED BY
A. STRYCHALSKI	P. Webb

DESCRIPTION

ANTIREFLECTIVE COATING, AVALANCHE

FIRST MADE FOR	GRP.
EO&D/SSD	

CONT.

REVISIONS

AP. BY [signature]	0
DATE 79-6-12	

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

270

I. PURPOSE

To evaporate an optical coating on the detector surface.

II. MATERIALS

A. Avalanche chips mounted to base assembly.
B. Silicon monoxide (Grade 49).

III. EQUIPMENT

A. As in P3013
B. Evaporation jigs.
C. Evaporation Boat (Baffle Box type).

IV. PROCEDURE

A. Refer to P3013 for evaporator equipment use.

B. Evaporate silicon monoxide as per Table I.

DEVICE TYPE	WAVELENGTH	COLOR OF EVAPORATED COATING. (Under Fluorescent Light).	THICKNESS OF COATING IN Å (With Film Thickness Monitor).
C30817	1060 nm	Light blue to Metallic	1360 Å
C30872			
C30899			
C30916			
C30884	900 nm	Medium blue	1150 Å
C30902	820 nm	Royal blue	1050 Å

TABLE I

SILICON MONOXIDE EVAPORATION COATING

TITLE
PROCEDURE

A SIZE | P4052

CODE IDENT NO. 95311 | SHEET 0 CONT'D ON SH 1

COMPILED BY G. HOUGHTON | CHECKED BY G HOUGHTON

RCA — RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION
SHELL WITH LIGHT PIPE

FIRST MADE FOR	GRP.
EO&D/SSD	

REVISIONS

AP. BY	R. S. Varden	0 x
DATE	73-12-14	

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE

NEXT ASS'Y.

4226-8/74

272

I. PURPOSE

To assemble a shell with a light pipe in it.

II. MATERIALS

A. Clean light pipes (note: light pipes need have only one good end).

B. 1264 epoxy.

C. H70E epoxy.

D. Clean inspected caps.

E. Polishing powder 1.0 µ.

F. Sandpaper 600 grit.

G. Dextalose paper.

H. Methanol.

I. Trichloroethylene .

III. EQUIPMENT

A. Light pipe positioning jigs.

B. Pointed tweezers suitable for handling light pipes and caps (anti-magnetic or demagnetized).

C. Dissecting microscope, magnification variable up to approximately 40X, equipped with top and bottom illumination (AO Forty recommended).

D. Hand tool with 0.010" tungsten wire at one end.

E. Oven set to 85°C.

F. Oven set to 120°C.

G. Epoxy dispensing syringe.

H. Glass plate with polishing cloth attached.

I. Ultrasonic bath.

J. Cleaning beakers and jigs.

K. Lapping jig.

L. Petri dishes.

273

IV. SAFETY PRECAUTIONS

(a) Epoxies can cause skin irritation. DO NOT ALLOW EPOXY TO COME IN CONTACT WITH SKIN OR EYES. Use appropriate protection for hands and fingers.

(b) If epoxy comes in contact with skin wash it off immediately with soap and water until all epoxy has been removed. In the event of eye contact flush immediately with water and obtain medical attention.

V. PREPARATIONS

A. Inspect and sort light pipes putting light pipes with two good ends in one dish and light pipes with one good end in a second dish. Use dextalose paper folded accordian style and lay the light pipes in the folds to prevent them moving. Place the light pipes with only one good end so that all "good" ends point the same way. To be "good" the end of the light pipe must be free of chips and cracks into the core area.

B. Prepare 1264 epoxy.

C. Prepare H70E epoxy.

D. Check that light pipe positioning jigs are clean and properly assembled. Arrange in Petri dishes.

VI. PROCEDURE

A. Place caps on light pipe positioning jigs checking to ensure they sit flat on the jig base.

B. Note: Use the g.1.e (good one end) light pipes first. When the supply is exhausted, use the g.2.e light pipes and keep these units distinct from the others.

With tweezers, put the good end of a light pipe gently through the hole in the cap and very gently move the light pipe around until it seats firmly in the correct position. Proceed to position light pipes in the rest of the units.

C. Using the dissecting microscope and with the hand tool place a suitable amount of 1264 epoxy at the base of the light pipe where it passes through the can, being careful not to dislodge the light pipe. Ensure that the clearance space between light pipe and shell is sealed with epoxy. Cure the assembled units 1 hour at 85°C.

D. After cooling use the hand tool to apply more 1264 epoxy to the light pipe where it passes through the can. The epoxy should form a large fillet to support the base of the light pipe. Cure 1 hour at 85°C.

E. After cooling place the units in the top of the lapping jig as it sits in the supporting collar, positioning the units as symmetrically as possible in the case of partial loads. With the aid of a dissecting microscope, use a syringe to deposit H70E epoxy at the inside base of the light pipe forming a fillet and covering any 1264 epoxy visible. Do not have H70E epoxy anywhere on the shell except the flat inside surface of the top. Cure 1 hour at 120°C.

VI. PROCEDURE (continued)

F. After cooling complete assembly of the lapping jig. All caps should be tightly held. If not, consult your supervisor.

G. Wearing safety goggles and working over a wastebasket, use tweezers to break off the light pipes about 2-3 mm above the top of the shell. Those units for which light pipes with two good ends were used will yield light pipes with one good end. These should be placed in the appropriate dish, good ends facing the same way.

H. Place the 600 grit sandpaper on approximately 15 sheets of dextalose paper. Begin sanding the light pipes by placing the jig lightly on the 600 grid sandpaper and, holding it so that the full weight of the jig does not bear on the light pipes, gently move the jig back and forth a few times. Blow off the jig and sandpaper with N_2, rotate the jig slightly and repeat the sanding procedure. Continue in this manner until all caps have reached the point where the epoxy surrounding the light pipe is being sanded. Reduce the thickness of the dextalose paper to about 7 sheets, blow off or replace the sandpaper, blow off the caps and inspect for problems such as cap movement, gross height differences, etc. Now the full weight of the jig may be allowed to bear on the caps as a stronger sanding action is employed. Rotate the jig after every few sweeps across the paper and check occasionally to see that sanding is procеding uniformly. Slight pressure may be applied to the jig during this stage of sanding. Change sandpaper as necessary to maintain good action. As the last few caps near the point of having all epoxy on the cap removed, revert to allowing the weight of the jig alone to maintain the grinding action. Try to have the jig rotate as it moves lightly across the paper and make the last few strokes across a used section of sandpaper to minimize deep scratches. Blow off any dust on the caps and examine for gross defects. There should be no 1264 epoxy left on the flat top of the can. If any problems are apparent, consult with your supervisor before proceeding.

I. Rinse off the polishing cloth on the glass plate under running water making sure there are no gritty particles present. Place an adequate amount of 1.0 μ lapping powder in the centre of the cloth, add sufficient water and make a good slurry. Rinse the lapping jig off under running water and place it wet on the polishing pad. Applying a slight pressure move the jig around in small circles utilizing all available space. Rotate the jig frequently and inspect the caps occasionally to ensure lapping is proceeding as expected. Change the lapping powder if it appears to be turning greyish. Continue lapping until a shiny polished surface is achieved. Consult your supervisor before terminating lapping. Rinse the jig and lapping plate well. Do not attempt to dry the caps.

VI. PROCEDURE (continued)

J. Remove the caps from the jig and place in the cleaning jig. Rinse the caps for 5 minutes in D.I. water, emptying the beaker at least 4 times during rinsing.

K. With the caps still in water, clean ultrasonically for 1 minute, rinse 5 minutes as in J and repeat.

L. Empty all water from the cleaning beaker then rinse the caps with methanol at room temperature. Empty and repeat the methanol rinse.

M. Empty the methanol and cover the caps with TCE. Heat to just below boiling, empty and repeat.

N. Remove the jig from the hot TCE and unload it, placing the caps flange down on dextolose. Let dry. Transfer the caps to a petri dish and inspect on a microscope with simultaneous top and bottom illumination. Check for cracks, chips and flaws in the light pipes, using the criteria set in "Preparations: A" for "good" ends. It should not be necessary to touch the shells - both ends of the light pipe may be inspected by focussing accordingly. Check the cap surface for cosmetic defects. Record yield on batch sheet.

VII. MAINTENANCE

A. Keep polishing pad clean and change as necessary.

B. Rinse the lapping jig parts under running water after use to remove lapping powder.

PROCEDURE

SIZE	A
	P4053
CODE IDENT NO.	95311
SHEET	0
CONT'D ON SH	1

COMPILED BY	CHECKED BY
A. STRYCHALSKI	[signature] 79-4-30

RCA RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

THERMOSONIC WIRE BONDING PROCEDURE (K&S 472/479 BALL)

FIRST MADE FOR	GRP.
EO&D/SSD	

CONT.

REVISIONS

AP. BY	[signature]	0
DATE	79-6-6	X

THIS DRAWING SUBJECT TO REVISION CONTROL

NEXT ASS'Y.

378

I. APPARATUS

1.1 K&S 472 or 479 Ball Bonder.

1.2 U.T.I. Generator or KS Model 4320A (on KS479).

1.3 Tool Micro Swiss 47 2-A-10-TIC special
CD .0021/tip size .0053 maxi.
or equivalent.

1.4 Work holders.

1.5 Gold Wire RCA #1972732.

1.6 Microscope A/O Stereo-Zoom .7 to 4.1X or equivalent.

1.7 B&L 20X eyepieces with cross hairs - Optional.

1.8 Suvoy tweezers 5A or S or 3C.

II. BONDER PREPARATION

2.1 Turn generator ON and let it warm up (30 minutes minimum).

2.2 Turn ON electronic flame off.

2.3 Tune the generator (after warm up period).

2.3.1 Set power 1 and power 2 to 5.0 and power switch to High.

2.3.2 Push calibrate button and tune frequency (screw on back of generator -model 472 only.) to have a <u>minimum</u> deflection.

2.3.3 The meter deflection must be below 0.2. If not, remove the tool, rotate it slightly and re-assemble the tool using the jig supplied. The top of tool must protrude 0 to 5 mils above the transducer.

2.3.4 Go to 2.3.2 if deflection is not below 0.2.

2.3.5 If after a few trials it is still not possible to tune below 0.2, call supervisor.

2.3.6 Reset controls to : Lo
P:3 T:3 1st bond.
P:3.5 T:3 2nd bond.

2.4 Check the forces 30g on first bond and 120g on second bond.

2.5 Mount the appropriate work holder on the bonder. Connect heater and set to approximately 100°C.

2.6 Load reject unit on work holder. Check that it is fastened securely and that work is flat.

2.7 Move manual tool support up, cycle machine to second search. Carefully bring tool down with manual lever. Adjust the work holders height so that tool is a few mils above the second search position.

2.8 Release button, the 2nd bond mark will be made on the metallization.

2.9 Inspect the imprint to see that the tool hits the metallization in a perpendicular fashion. If the tool front and back imprints are not even, readjust the 2nd search height and work holder height to get the best mark. Do not readjust the 2nd search height knob after this.

2.10 Adjust the 1st search height and loop using the appropriate knobs.

2.11 Check that at search position the appropriate control is under pressure and that all others are released. (model 472 only). If this condition does not prevail, call supervisor.

2.12 Thread wire, (loop position) and adjust the gas wire feed control to lowest hiss possible. Wire will flutter very slightly.

2.13 Cycle machine to loop. Bend wire under tool and bond. This is required to form a ball.

2.14 Make 1st bond and check ball size. Readjust the reset knob to control the ball size. Clockwise rotation results in a larger ball. Complete second bond.

2.15 Perform a number of bonds to fine tune the adjustments of power, time and reset height to obtain optimum bonds as per bond criteria in section 4.

2.16 When machine operation is satisfactory perform full tests on a number of bonds as per P4007.

III. BONDING OPERATION

3.1 Load work piece in holders.

3.2 Align microscope cross hairs with first or second bond position as desired.

3.3 Cycle to first search, align and bond, move to second bond region, go to second search, align, bond.

3.4 Inspect visual appearance of bond to criteria of section 4.

3.5 Move to next bond, perform steps 3.3 and 3.4.

3.6 When all bonds for the condition set have been made, record on the bond record sheet as per P4007.

3.7 If more than one bond attempt was required, record the location and the number of tries.

3.8 Whenever the machine adjustments have to be changed or when the bonding pad metallization is changed, new pull test data must be generated to check machine operation.

3.9 On long production jobs, make pull tests at the beginning and at the end of each day.

IV. BOND CRITERIA

4.1 Ball size 2 to 4 wire diameters.

4.2 Visible ball deformation.

4.3 No ball lift in pull test.

4.4 No wedge bond lift except when pull test peels wire.

4.5 For pull test values, see P4007.

TITLE PROCEDURE	A SIZE	P4060
		CODE IDENT NO 95311 | SHEET 0 CONT'D ON SH 1

COMPILED BY	CHECKED BY	
M. LEROUX/R.E. CARDINAL	R.E.C. 79-12-20	RCA RCA LIMITED STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

FIBER OPTIC CONNECTOR
"X" MEASUREMENT

FIRST MADE FOR	GRP.

REVISIONS

AP. BY	R.E. Cardinal	0 x
DATE	79-12-20	

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE

NEXT ASS'Y.

282

1. EQUIPMENT AND MATERIALS

1.1 Depth gauge Starrett 445 or equivalent.

1.2 Chemical stand (to support gauge).

1.3 Lamp with magnifying glass.

1.4 X-Measurement Record Sheet.

2. PROCEDURE

2.1 Set gauge to value lower than value of X anticipated.

2.2. Place fiber optic connector/cap on depth gauge.

2.3 Rotate micrometer barrel till connector/cap moves.

2.4 Back off micrometer till movement stops.

2.5 Record value of X on "X-Measurement Record Sheet" shown on Figure I.

TO8 · TO-1"Ø

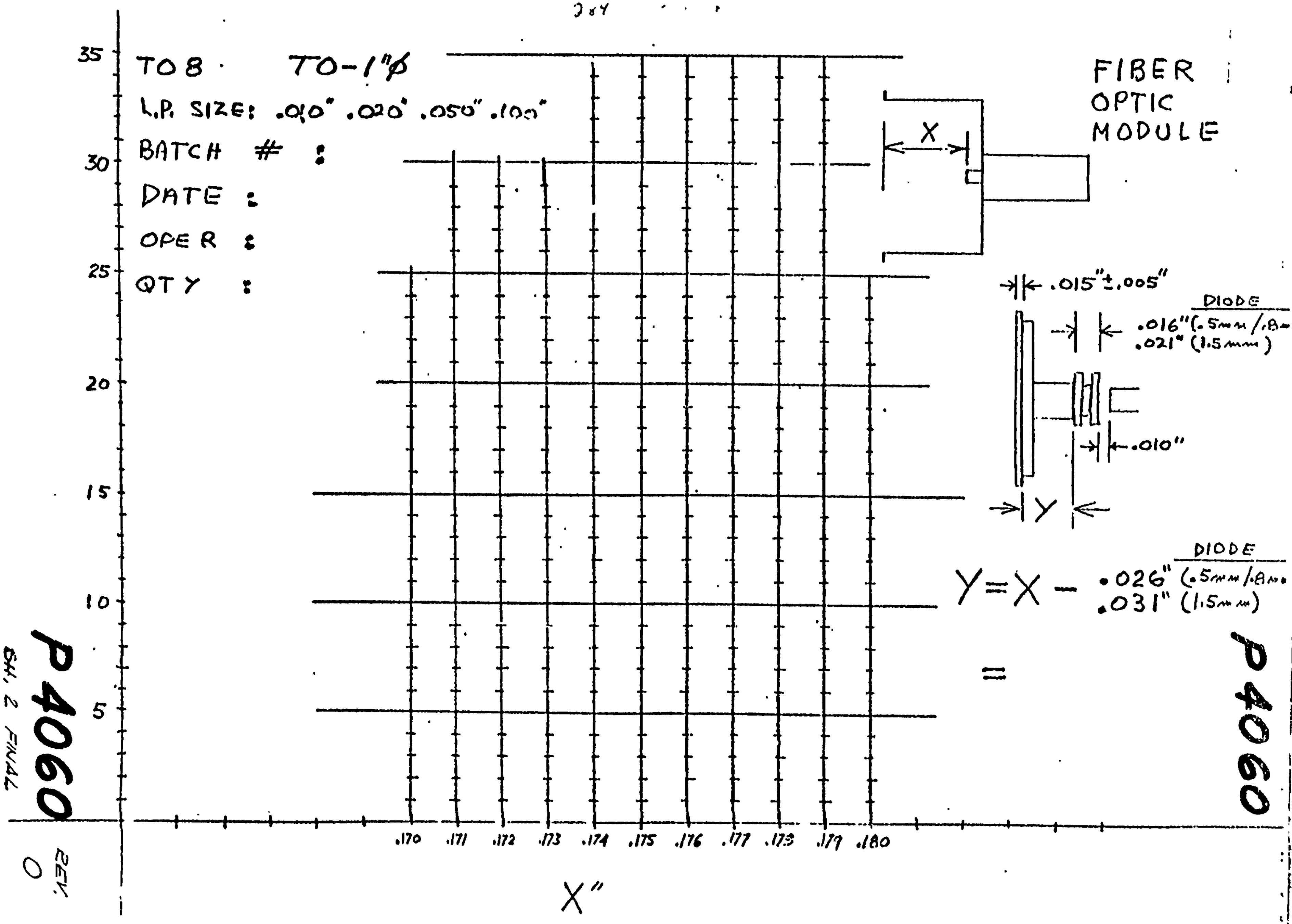
L.P. SIZE: .010" .020" .050" .100"

BATCH # :

DATE :

OPER :

QTY :



P4060

P4060

SH. 2 FINAL

REV. 0

TITLE		A SIZE	P4061
PROCEDURE		CODE IDENT NO 95311	SHEET 0 CONT'D ON SH 1
COMPILED BY ¹.LEROUX/ A.STRYCHALSKI	CHECKED BY R.P.L. 79-12-20	RCA	RCA LIMITED STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

HEADER PIN STRAIGHTENING

FIRST MADE FOR	GRP.

REVISIONS

AP. BY R.P. Paradis	0 x
DATE 79-12-20	

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE ____________

NEXT ASS'Y.

1. PURPOSE

To straighten leads on bases.

2. PARTS

Pin strightening jig SK-WR-720.

3. EQUIPMENT

3.1 Tweezers

4. PROCEDURE

4.1 Position bottom pins of header into the jig using tweezers.

4.2 Position top jig over base and push header into bottom jig.

4.3 Remove header from jig.

TITLE		A SIZE	P4062
PROCEDURE			CODE IDENT NO. 95311 | SHEET 1 CONT'D ON SH 2
COMPILED BY LEROUX/A.STRYCHALSKI	CHECKED BY R.A.L. 79-12-20	RCA	RCA LIMITED STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

SPOT WELDING

TABS TO HEADER

FIRST MADE FOR	GRP.

REVISIONS

AP. BY R. L. Lachand

DATE 79-12-20

0x

287

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE

NEXT ASS'Y.

1. PURPOSE

To weld moly tabs to header.

2. PARTS

2.1 Bases

2.2 Moly Tabs or Kovar Tabs

3. EQUIPMENT

3.1 Unitek Welder no. 1-156

3.2 Unitek Weld Head 2-101, with bottom plate and #2 top electrode.

3.3 Bausch & Lomb Microscope

3.4 Welding jig (SK-WR-613)

3.5 Scalpel

3.6 Tweezers

4. PROCEDURE

4.1 Switch on power.

4.2 Rotate pulse selector to position "I".

4.3 Set weld heat to "7".

4.4 Press power level switch to "25" WS.

4.5 Adjust force gauge to "50".

4.6 Mount header on bottom electrode.

4.7 Locate tabs on base.

4.8 Bring down electrode onto tab.

4.9 Record weld parameters on Welder Schedule Sheet.

5. ACCEPTANCE CRITERIA

5.1 To test weld, insert scalpel blade under tab and pry up; if tab comes off, adjust power to a higher level.

Too high a power level will cause burn marks on tab and electrode.

TITLE		
PROCEDURE	A SIZE	P4063
	CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

COMPILED BY	CHECKED BY
M.LEROUX/A.STRYCHALSKI	RSP 79-12-20

RCA — RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

SUBSTRATE BURNISHING

FIRST MADE FOR	GRP.

REVISIONS

AP. BY	R. L. Cardinal	0 X
DATE	79-12-20	

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE ______

NEXT ASS'Y.

1. PURPOSE

To burnish solder pads on thick film substrates.

2. MATERIALS

2.1 Pencil eraser Stenorace 1207 or equivalent.

2.2 Trichlorethylene.

2.3 Methanol.

2.4 Acetone.

3. EQUIPMENT

3.1 Microscope

3.2 Nitrogen gun

3.3 Tweezer

4. PROCEDURE

4.1 Under a microscope, gently abrade all the solder pads with the pencil eraser, till surface is shiny.

4.2 Blow off eraser residue with nitrogen gun.

4.3 Place substrates in bath of equal quantities of trich., meth. and acetone.

4.4 Simmer for approximately 5 minutes.

4.5 Remove substrates from solvent and blow dry.

TITLE PROCEDURE	A SIZE	P4064
	CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

COMPILED BY	CHECKED BY
R.E. CARDINAL	R.E.C. 79-12-20

RCA RCA LIMITED
STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

POST SURFACING
FIBER OPTIC MODULES

FIRST MADE FOR	GRP.

REVISIONS

AP. BY	R.E. Cardinal	0 X
DATE	79-12-20	

182

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE

NEXT ASS'Y.

1. EQUIPMENT AND MATERIALS

1.1 Milling machine, Bridgeport or equivalent.

1.2 Magnetic chuck, Eclipse or equivalent.

1.3 Header support jig

1.0 in. dia : SK-WR-463
TO-8 (0.6 in. dia.): SK-WR-310/311/312

1.4 End mill approx. 2X post diameter and very sharp.

2. PREPARATION

2.1 The center piece of the jig must be epoxied to the magnetic chuck.

3. OPERATION

3.1 Measure the thickness of the flange on the lot of parts supplied. If the thickness differs by more than ± 1 mil, segragate parts into groups with ± 1 mil tolerance.

3.2 Load part in jig and secure down using hold down part of jig and magnetic chuck.

3.3 Mill off top of post in cuts of 20mils or less, till desired Y value is obtained. Note that the Y value is the distance from the top of the post to the top of the flange.

TITLE	A SIZE	P5028
TEST PROCEDURE (ELECT.)	CODE IDENT NO. 95311	SHEET 0 CONT'D ON SH 1

COMPILED BY	CHECKED BY
M. TEARE	79-12-20

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STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

C30941E FIBER OPTIC MODULE

FIRST MADE FOR	GRP.
MMT 77	

REVISIONS

AP. BY	0
DATE	

293

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE

NEXT ASS'Y.

4226-8/74

Description of Test Methods

Responsivity

The module shall be illuminated with a source of wavelength 820 $\pm$ 5nm, obtained by filtering of a tungsten filament source. The radiation shall be chopped at a frequency of 800 Hz. (The power incident on the detector (P_{opt}) shall be measured using a standard reference detector). The bias voltage on the module is increased until the responsivity, defined as the ratio of the rms output voltage (V_{out}) to P_{opt} attains the required value. The output of the module shall be A.C. coupled to a 50 ohm load for this measurement. The bias voltage (V_{DR}) is recorded in the data log column A. The required value of responsivity will exceed 1.3 x 10^6 v/w over the temperature range -50°C to +71°C and will be recorded in column G of the data log. (Test Method C).

Output Offset Voltage

With the detector in the dark, the reverse bias voltage is set to V_{DR}. The voltage appearing at the module output is the preamplifier output offset voltage (V_{oo}). This is recorded in the data log column B. (Test Method B).

Power Consumption

With the detector in the dark, the high voltage is set to +550 VDC, and the photodiode reverse bias to V_{DR}. With $\pm V_{cc} = \pm$ 6.0 volts, the currents flowing through the + V_{cc} and - V_{cc} rails shall be measured and designated I^+ and I^- respectively. These currents are recorded in the data log columns C and D. The current I flowing in the high voltage rail will be measured and recorded in column E. The value of P_{in}, defined as

$$6\,(I^{+} + I^{-}) + 550\,I = P_{in}$$

shall not exceed 100 mW, over the temperature range of $-50^{o}C$ to $+71^{o}C$. (Test Method A).

Spectral Noise Voltage Density

The detector shall be in the dark at a reverse bias voltage V_{DR}. At center frequencies of 1, 16, 32 and 48 MHz and bandwidth Δf = 10 KHz or less the spectral noise voltage density V_n shall be calculated according to the relation

$$V_{out} = V_n \sqrt{\Delta f}$$

The maximum values of V_n shall be as follows:

$25^{o}C$	1MHz	5.0×10^{-8} v/Hz$^{\frac{1}{2}}$
	16, 32, 48 MHz	1.0×10^{-7} v/Hz$^{\frac{1}{2}}$
$-50, +71^{o}C$	1MHz	1.4×10^{-7} v/Hz$^{\frac{1}{2}}$

and V_n shall be recorded in the data log column F. (Test Method D).

Preamplifier Output Impedance

The module responsivity (R) shall be measured as in test method C. Maintaining the same power level (P_{opt}) and bias voltage, the 50 ohm load will be replaced by a load greater than 1 MΩ, and a new value of V_{out} obtained. The output impedance of the amplifier if obtained from the relation

$$Z_o = \frac{50\,V_{out}}{RP_{opt}}$$

and recorded in the data log column H. (Test Method E). The value of Z_o shall be less than 50 ohms.

Output Swing

A Gallium Aluminum Arsenide LED ($\lambda = 820 \pm 5$ nm) modulated with a 50 ns pulse width and a repetition rate of 1 MHz or less, shall be used for this measurement. The power of the radiation from the modulated source shall be controlled by varying the drive current. The LED illumination falling on the module detector shall be increased until the module output voltage is limited by pulse clipping. The output voltage at which pulse clipping begins will be defined as the upper limit of the output swing (V_s). The value of V_s will be recorded in the data log column K and shall be greater than 1 volt. (Test Method F).

Module Bandwidth

Module Bandwidth shall be inferred from the illuminated noise voltage spectral density. The module shall be reverse biased at V_{DR}. An unmodulated source of illumination of arbitrary spectral distribution will be incident on the module, of intensity such that the photodiode photocurrent is 10 µADC. The module output will be connected to a spectrum analyzer whose output is monitored on an x-y recorder, displaying noise voltage density versus center frequency in normalised units. The effective bandwidth will be 10 KHz over the frequency range 100 KHz to 70 MHz. From the recorded trace, determination of the frequency (BW) at which the noise voltage is 3db below its value at 100 KHz, yields the module bandwidth directly. The bandwidth shall be greater than 20 MHz.

A similar trace will be recorded for the detector in the dark and both traces recorded in the data log (Figure 4). (Test Method H).

Risetime and Falltime

The module shall be reverse biased at V_{DR} and illuminated by radiation from a Gallium Indium Arsenide LED (λ = 820 $\pm$ 5 nm). The LED shall have a rise and fall time less than 5 ns, and shall be operated with a minimum pulse width of 100 ns. The depth of modulation of the LED shall be varied so that the varying component of the module output has a 250 mV amplitude suitable for oscilloscope presentation. The rise time will be the time elapsed between 25 mV and 225 mV amplitude on the pulse leading edge and the fall time the time between 225 mV and 25 mV amplitude of the trailing edge. The rise and fall times will be recorded in the data log, columns I and J, and shall not exceed 22 ns, throughout the temperature range $-50^{\circ}C$ to $+71^{\circ}C$. (Test Method G).

TERMS AND SYMBOLS

V_{DR} - Diode reverse voltage

V_{OO} - Output offset voltage

I^{+} - Positive DC supply current

I^{-} - Negative DC supply current

HV_{I} - High voltage supply current

V_{n} - Spectral output noise voltage density

R - Responsivity (volts/watt)

Z_{o} - Preamplifier output impedance

t_{r} - Risetime

t_{f} - Falltime

V_{out} - Output offset voltage

V/W - Volts/watt

V_{DRB} - Diode reverse voltage breakdown

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P5028

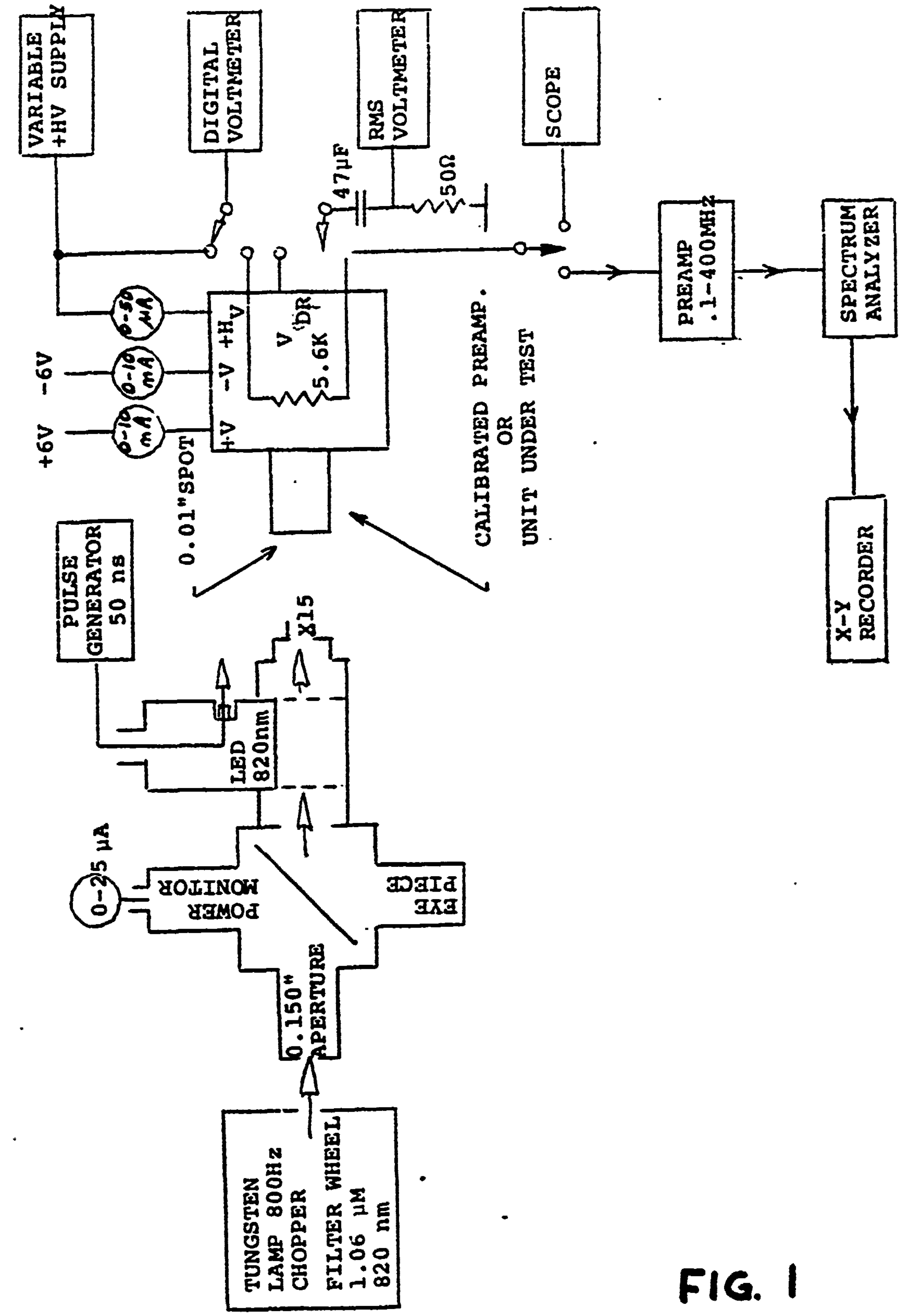

FIG. 1

A SIZE | P5028 | REV. 0

CODE IDENT NO. 95311 | SHEET 6 | CONT'D ON SH 7

4210A-1/71

RCA LIMITED
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P5028

300 FIGURE 2

DATE ____________ SERIAL NO. ____________

TEST SEQUENCE ____________ TEST BY ____________

TEST	A	B	C	D	E	F	G	H	I	J	K
SYMBOL	V_{DR}	V_{OO}	I^+	I^-	HV_I	V_n	R	Z_o	t_r	t_f	V_{out}
TEST CONDITIONS	$P_D = 0$						$\lambda = 820$ nm				
	RESPONSIVITY SET TO $\geq 1.3 \times 10^6$ V/W										
						F=1.0MHz ΔF=10 MHz	$R = \frac{O/P\ V}{P_D}$		PULSE WIDTH = 50 ns		
MAX		-0.3	6.0mA	6.0mA	50µA	5.0 µV	-	50Ω	22ns	22ns	1.0V
MIN		-1.3				-	1.3×10^6 V/W	-	-	-	-
TEMP +22°C+5 TEST I											
+22°C±5 TEST II											
+71°C+5 TEST III						NOTE 1					
-50°C+5 TEST IV											

NOTE 1 V_n max = 14.0 µV at 71°C

A SIZE | P5028 | REV. 0

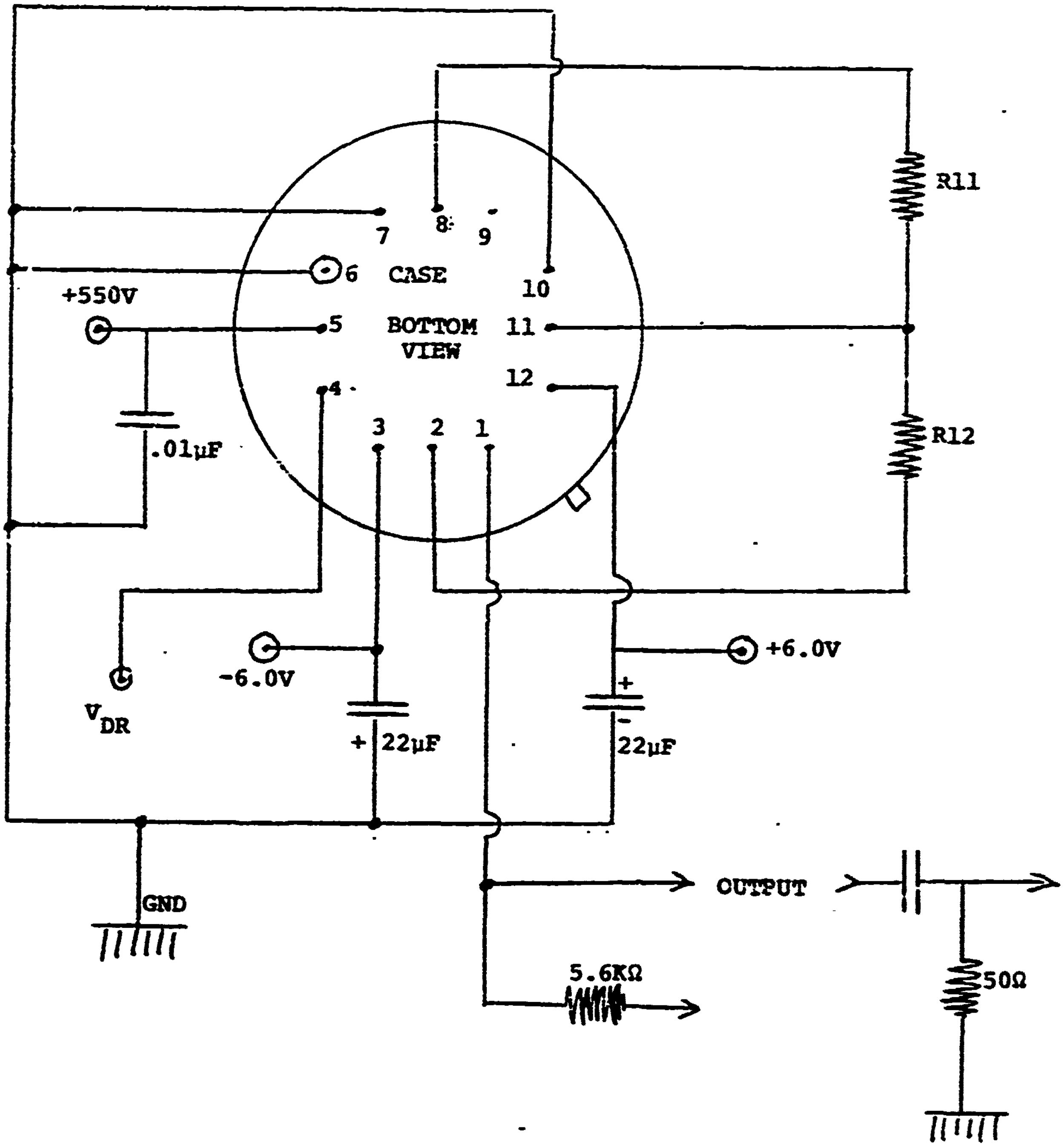
CODE IDENT NO. 95311 SHEET 7 CONT'D ON SH 8

4219A-1/71

SAPDM-2 EXTERNAL CONNECTIONS

FIGURE 3

SERIAL #



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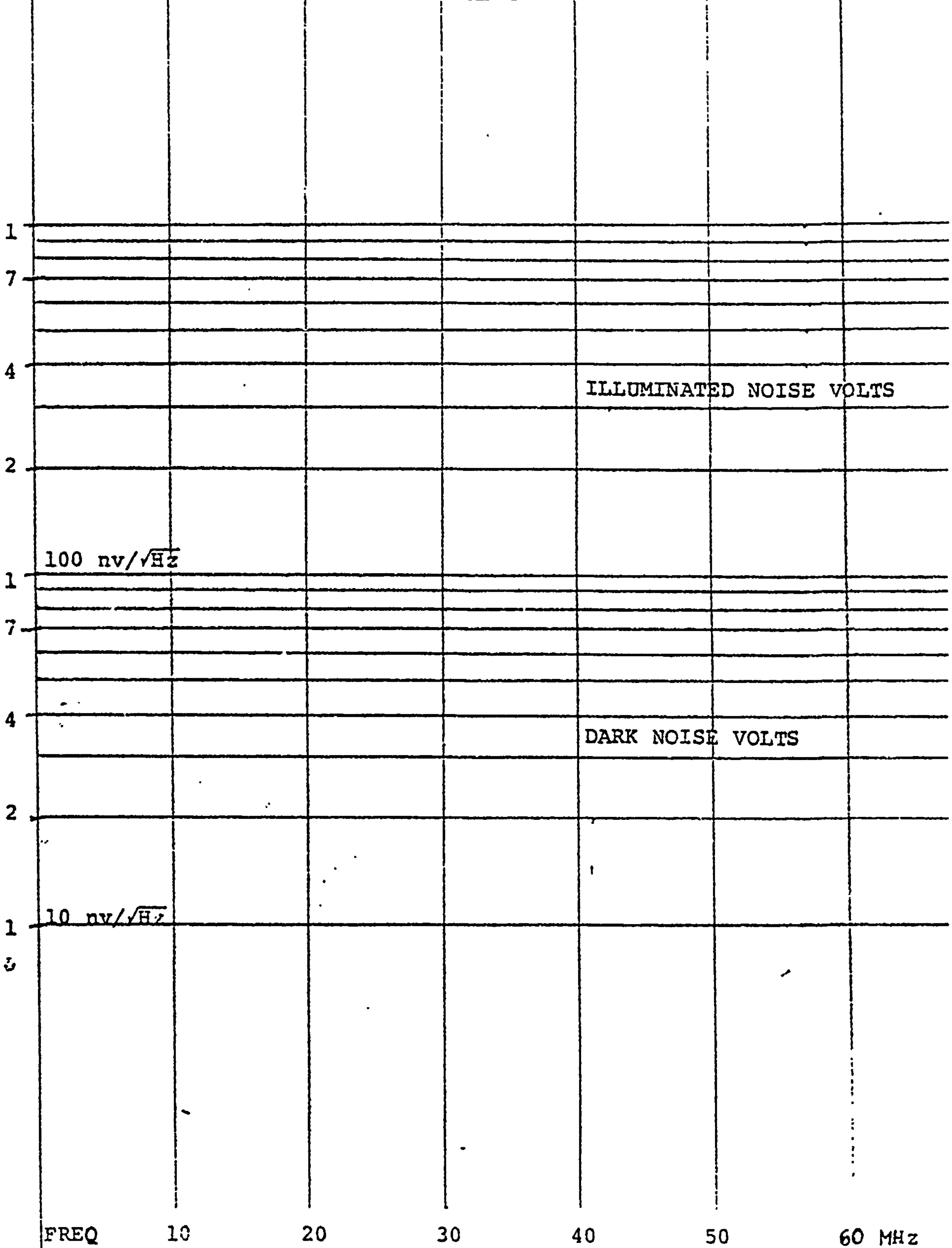
P5028

FIGURE 4



A SIZE P5028 REV. 0

CODE IDENT NO 95311 SHEET 9 CONT'D ON SH FIN

TITLE

TEST PROCEDURE (ELECT.)

A

SIZE

P 5029

CODE IDENT NO. 95311 | SHEET 0 | CONT'D SHEET 1

COMPILED BY

M. TEARE

CHECKED BY

79-12-20

RCA LIMITED

STE. ANNE DE BELLEVUE, QUEBEC

DESCRIPTION

C30944E RANGEFINDER MODULE

FIRST MADE FOR	GRP.
MMT77	

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REVISIONS

AP. BY	0
DATE	x

THIS DRAWING SUBJECT TO REVISION CONTROL

COMMODITY CODE

NEXT ASS'Y.

4226-8/74

303

Description of Test Methods

Responsivity

The module shall be illuminated with a source of wavelength 1060 $\pm$ 5 nm, obtained by filtering of a tungsten filament source. The radiation shall be chopped at a frequency of 800 Hz. (The power incident on the detector (P_{opt}) shall be measured using a standard reference detector). The bias voltage on the module is increased until the responsivity, defined as the ratio of the rms output voltage (V_{out}) to P_{opt}, attains the required value. The output of the module shall be A.C. coupled to a 50 ohm load for this measurement. The bias voltage (V_{DR}) is recorded in the data log column G. The required value of responsivity will be 3.4 x 10^5 v/w at 22 $\pm$ 5°C, and 2.7 x 10^5 v/w at 71 $\pm$ 5°C and -50 $\pm$ 5°C. (Test Method G).

Reverse Voltage Breakdown

With the module in the dark, the reverse bias voltage is increased until a dark current of 10 μA flows through the photodiode. An external 100 KΩ load shall be used for this measurement. The breakdown voltage (V_{DRB}) is recorded in the data log column A. (Test Method A).

Output Offset Voltage

With the detector in the dark, the reverse bias voltage is set to 100 volts below V_{DRB}. The voltage appearing at the module output is the preamplifier output offset voltage (V_{OO}). This is recorded in the data log column B. (Test Method B).

Power Consumption

With the detector in the dark, the reverse bias voltage is set to $V_{DRB} - 100$. With $\pm V_{cc} = \pm 6.0$ volts, the currents flowing through the $+V_{cc}$ and $-V_{cc}$ rails shall be measured and designated I^+ and I^- respectively. These currents are recorded in the data log columns C and D. The dark current I_D flowing in the photodiode will be measured. The value of P_{in}, defined as

$$6(I^+ + I^-) + I_D(V_{DRB} - 100) = P_{in}$$

shall not exceed 75 mW, over the temperature range of $-50^{\circ}C$ to $+71^{\circ}C$. (Test Methods, C,D).

Preamplifier Spectral Noise Voltage Density

The detector shall be in the dark, at a bias voltage of $V_{DRB} - 100$. At a center frequency of 1.0 MHz and appropriate quality factor $Q > 100$, the spectral noise voltage density (V_{np}) shall be determined according to the relation

$$V_{out} = V_{np} \sqrt{\Delta f}$$

where V_{out} is the rms voltage appearing at the module output and Δf is the noise equivalent bandwidth. The value of V_{np} is recorded in the data log column E. (Test Method E).

Spectral Noise Voltage Density

The detector shall be in the dark at a reverse bias voltage V_{DR}. At center frequencies of 1, 16, 32 and 48 MHz and bandwidth $\Delta f = 10$ KHz or less, the spectral noise voltage density V_n shall be calculated according to the relation

$$V_{out} = V_n \sqrt{\Delta f}$$

The maximum values of V_n shall be as follows:

25°C	1MHz	5.0×10^{-8} V/Hz^{½}
	16,32, 48 MHz	1.0×10^{-7} V/Hz^{½}
-50,+71°C	1MHz	1.4×10^{-7} V/Hz^{½}

and V_n shall be recorded in the data log column F. (Test Method F).

Preamplifier Output Impedance

The module responsivity (R) shall be measured as in test method G. Maintaining the same power level (P_{opt}) and bias voltage, the 50 ohm load will be replaced by a load greater than 1MΩ and a new value of V_{out} obtained.

The output impedance is obtained from the relation

$$Z_0 = \frac{50\ V_{out}}{RP_{opt}}$$

and recorded in the data log column H. (Test Method H). The value of Z_0 shall be less than 50 ohms.

Output Swing

A Gallium Indium Arsenide LED (λ = 1060 ± 5 nm) modulated with a 50 ns pulse width and a repetition rate of 1MHz or less, shall be used for this measurement. The power of the radiation from the modulated source shall be controlled by varying the drive current. The LED illumination falling on the module detector shall be increased until the module output voltage is limited by pulse clipping. The output voltage at which pulse clipping begins will be defined as the upper limit of the output swing (V_s).

The value of V_S will be recorded in the data log column K and shall be greater than 1 volt. (Test Method K).

Module Bandwidth

Module Bandwidth shall be inferred from the illuminated noise voltage spectral density. The module shall be reverse biased at V_{DR}. An unmodulated source of illumination of arbitrary spectral distribution will be incident on the module, of intensity such that the photodiode photocurrent is 10μADC. The module output will be connected to a spectrum analyzer whose output is monitored on an x-y recorder, displaying noise voltage density versus center frequency in normalised units. The effective bandwidth will be 10 KHz over the frequency range 100 KHz to 70 MHz. From the recorded trace, determination of the frequency (BW) at which the noise voltage is 3db below its value at 100 KHz, yields the module bandwidth directly. The bandwidth shall be greater than 20 MHz.

A similar trace will be recorded for the detector in the dark and both traces recorded in the data log (Figure 4), (Test Method M).

Risetime and Falltime

The module shall be reverse biased at V_{DR} and illuminated by radiation from a Gallium Indium Arsenide LED ($\lambda = 1060 \pm 5$ nn). The LED shall have a rise and fall time less than 5 ns, and shall be operated with a minimum pulse width of 50 ns. The depth of modulation of the LED shall be varied so that the varying component of the module output has a 250 mV amplitude suitable for oscilloscope presentation. The rise time will be the time elapsed between 25 mV and 225 mV amplitude on the pulse leading edge and the fall time the time between 225 mV and 25 mV amplitude of the trailing edge. The rise and fall times will be recorded in the data log, columns I and J, and shall not exceed 18 ns, throughout the temperature range $-50^{\circ}C$ to $+71^{\circ}C$. (Test Method I,J).

Recovery Time

At room temperature, the module shall be reverse biased so that the responsivity is equal to 2.7×10^5 v/w, at $\lambda = 1060$ nm. The module will then be illuminated by a pulsed optical laser. It is the intention to use a 1060 $\pm$ 5nn laser for this measurement. If the existing state of the art availability of solid state lasers is inadequate, a 900 $\pm$ 20 nn laser may be substituted. The modulation and intensity of the source will be varied so as to provide pulses of maximum width 5ns, and minimum power equivalent to 0.5w at 1060 nm. A reference photodiode may be used to establish this equivalent power.

The module output will be displayed on an oscilloscope. The recovery time will be the elapsed time between the 100 mV points of the leading and trailing edges, and shall not exceed 660 ns. The recovery time will be recorded in the data log (Test Method N).

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TERMS AND SYMBOLS

V_{DR}	-	Diode reverse voltage
V_{OO}	-	Output offset voltage
I^+	-	Positive DC supply current
I^-	-	Negative DC supply current
HV_I	-	High voltage supply current
V_n	-	Spectral output noise voltage density
R	-	Responsivity (volts/watt)
Z_o	-	Preamplifier output impedance
t_r	-	Risetime
t_f	-	Falltime
V_{out}	-	Output voltage
V/W	-	Volts/watt
V_{DRB}	-	Diode reverse voltage breakdown

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P5029

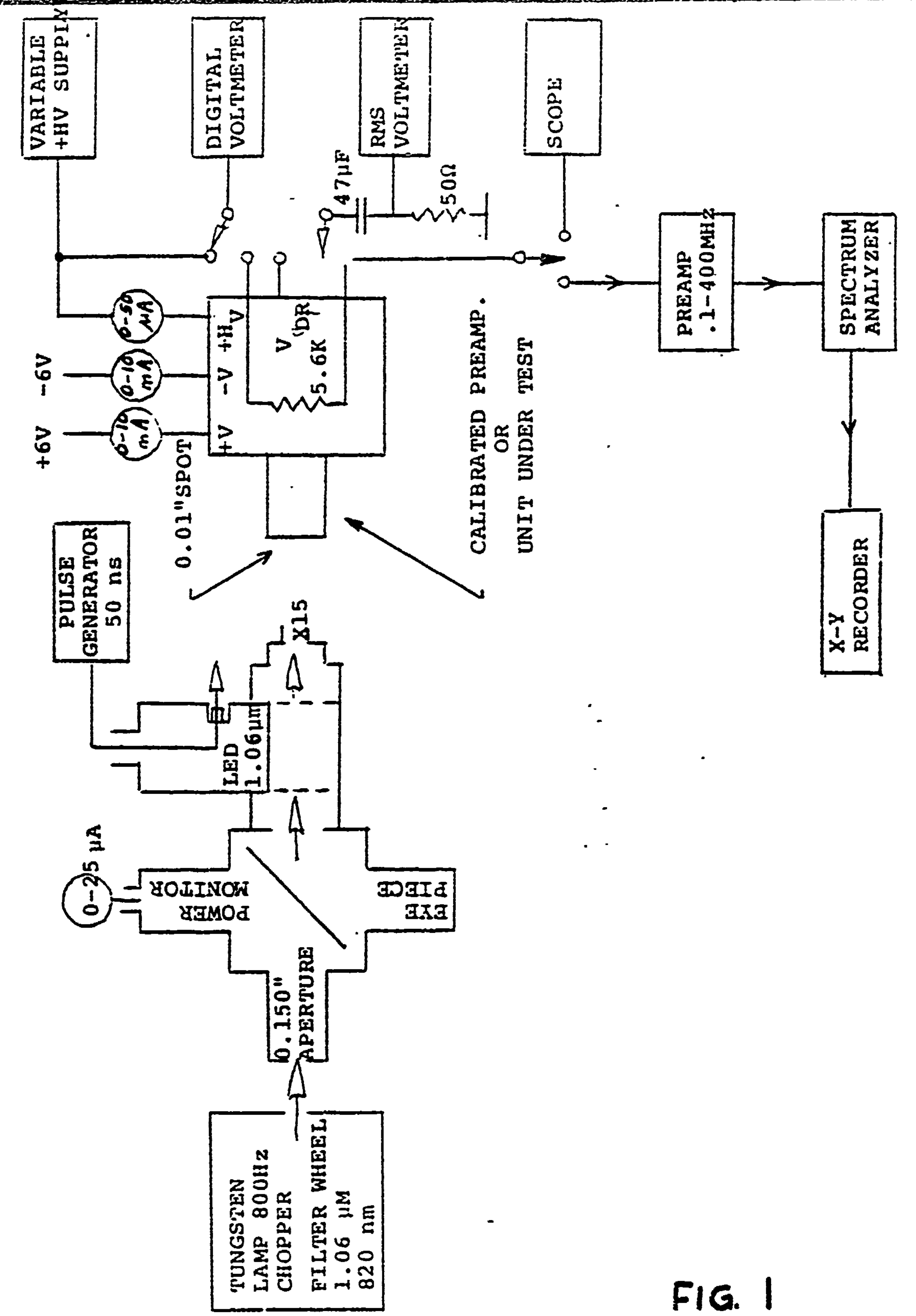

FIG. 1

A SIZE | P5029 | REV. 0

CODE IDENT NO 95311 | SHEET 7 | CONT'D ON SH 8

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P 5029

FIGURE 2

DATE __________ SERIAL NO. __________

TEST SEQUENCE __________ TESTED BY __________

TEST	A	B	C	D	E	F	G	H	I	J	K
SYMBOL	V_{DRB}	V_{oo}	I^{+}	I^{-}	V_n	V_n	V_{DR}	Z_o	t_r	t_f	V_{out}
TEST CONDITIONS	$P_D = 0$						$\lambda = 1.06\mu m$				
	10 µA	$V_{DR} = V_{DRB} - 100$				NOTE 1			$V_{DR} - V_{DRB} - 100$		
					FREQ = 10.0MHz ΔF = 10 KHz				PULSE WIDTH = 50ns		
MAX		-0.3	4.0mA	4.0mA	5.0µV	5.0µV		50Ω	18ns	18 ns	
MIN		01.3			-	-		-	-	-	1.0V
TEMP +22°C $\pm$ 5 TEST I											
+22°C $\pm$5 TEST II											
+71°C $\pm$5 TEST III						NOTE 2					
-50°C $\pm$5 TEST IV											

NOTE 1 TEST I R = 3.4×10^5 V/W
TEST II R = 3.4×10^5 V/W
TEST IIIR = 2.7×10^5 V/W
TEST IV R = 2.7×10^5 V/W

NOTE 2 V_n max = 14.0 µV at +71°C

TEST N t_{rev}

MAX 660 ns

MEASURED __________

A SIZE | P 5029 | REV. 0

CODE IDENT NO 95311 | SHEET 8 | CONT'D ON SH 9

TEST SOCKET

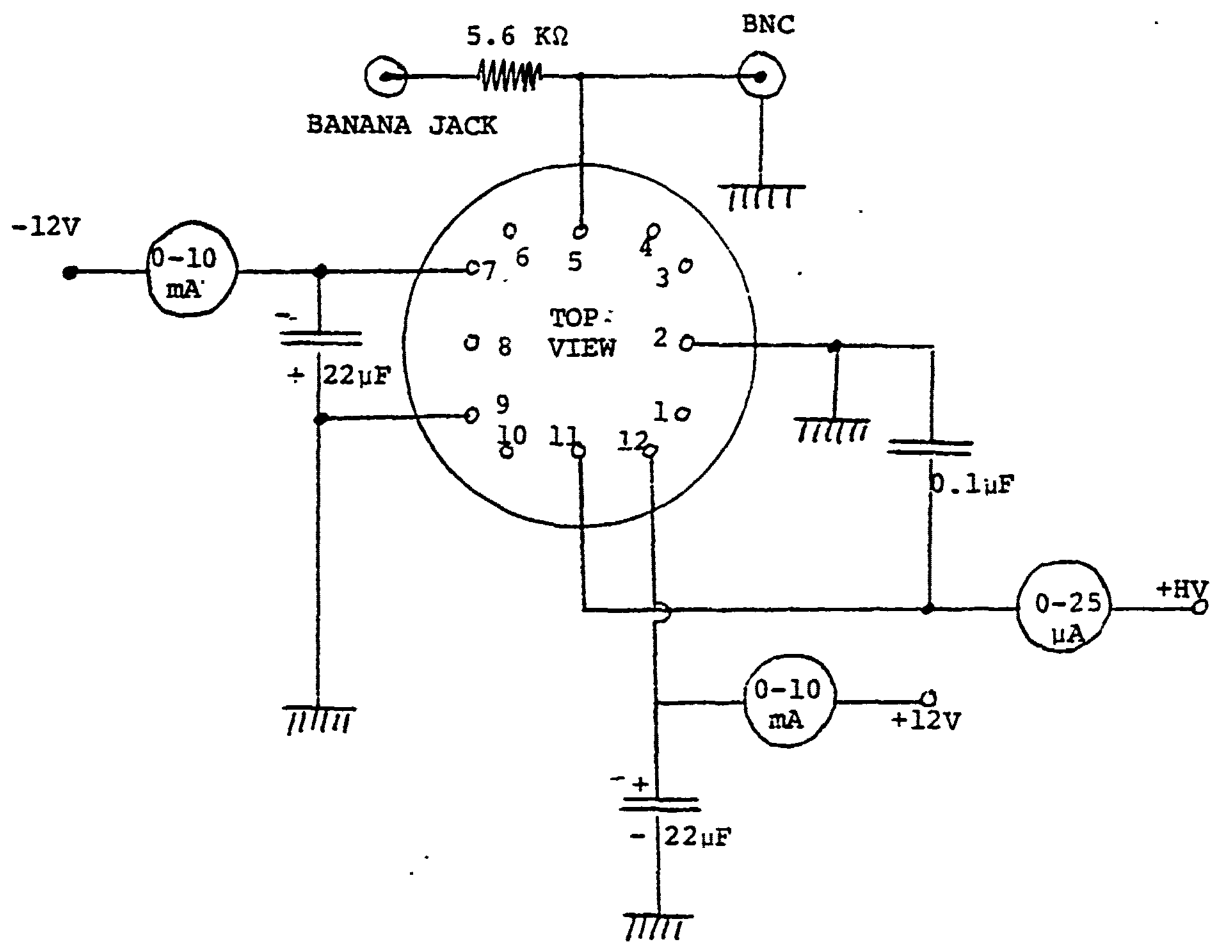
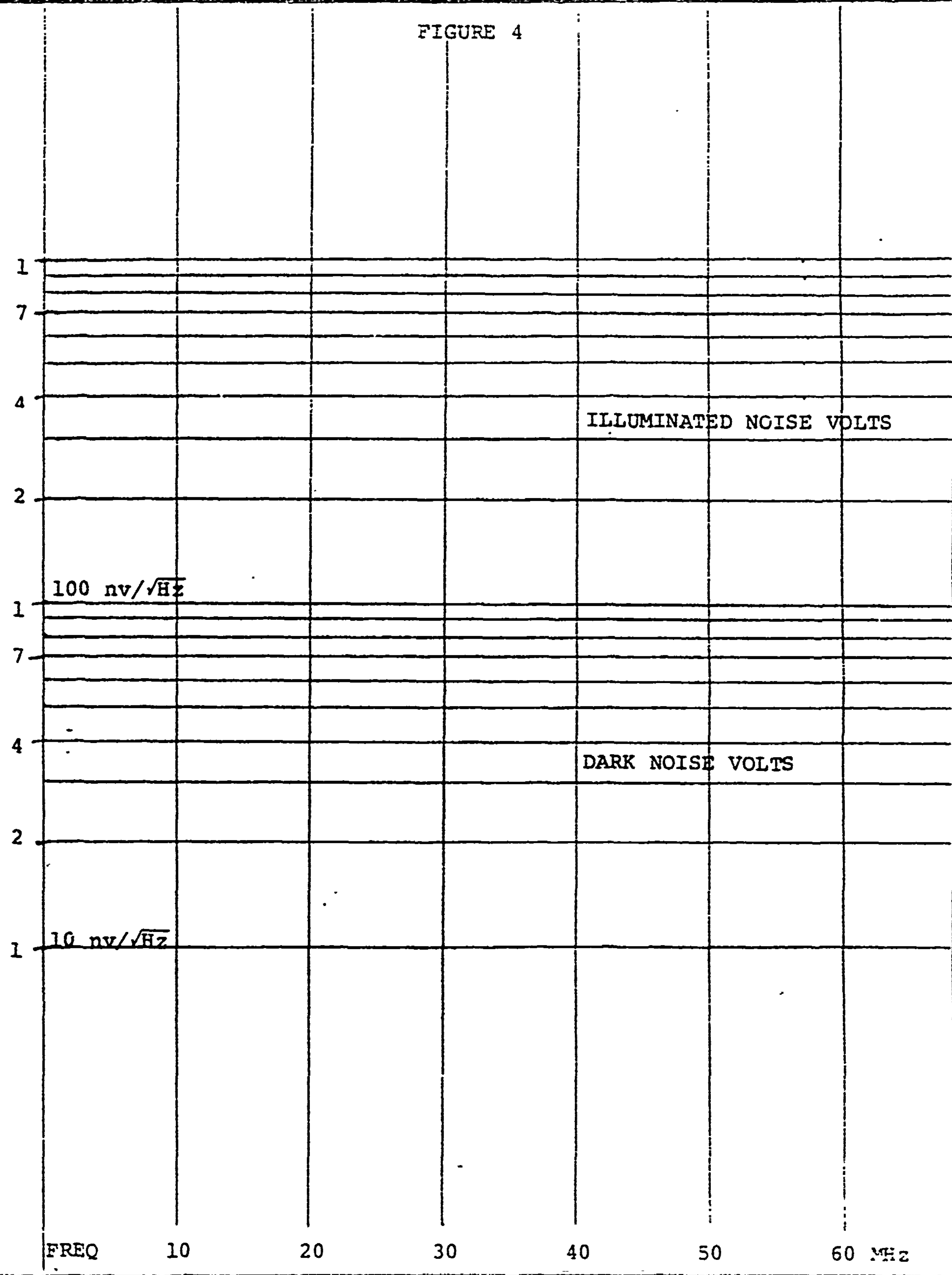


FIGURE 3

FIGURE 4


1
7
4
ILLUMINATED NOISE VOLTS
2
100 nv/√Hz
1
7
4
DARK NOISE VOLTS
2
10 nv/√Hz
1
FREQ
10
20
30
40
50
60 MHz

RCA Electro Optics

Quality Control Procedures

Specification QM-0015

Subject CAP ASSEMBLY INSPECTION

Date May 25, 197

	Issue	Issue	Issue	Issue
0	May 25, 1973			

<u>SAMPLING:</u> On Standard Product Inspection Level II, A.Q.L. 4.0 the basis for sampling shall be MIL-STD-105.

On custom-made product inspect 100% to applicable drawings.

<u>EQUIPMENT:</u>

a) Clean Tweezers
b) Microscope, Binocular 20X
c) Veeco Helium Leak Detector (M.S.90A.B)
d) Package Mounting Fixture
e) Vernier Caliper

<u>PROCEDURE:</u>

1) Mechanical dimensions as per product specification. Make sure Procedure QM-0011 or QM-0012 (Incoming Inspection) has been satisfied.

2) Inspect window for inclusions, bubbles, scratches, etc., as per product specification.

   If window is soldered, no excess solder shall be visible. If window is coated with anti-reflection coating, check for correct transmission.

3) <u>Gold Plating</u>

   3.1 Inspect gold plating surface for uniformity which should be smooth, dirt and stain free. Heat units for 12 hours at 180°C. No discolouration should occur.

   3.2 Plating must not flake or peel when rubbed with Q-tip; attach a piece of scotch tape on plated area, peel tape off. Plating must not come off on tape.

   3.3 Take one sample per lot (if lot over 500), crush or bend the outer member and using 15X magnification examine the parts for adherence. Any loose or peeling gold is cause for rejection.

RCA Electro Optics

Quality Control Procedures

Specification QM-0015

Date May 25, 19

Subject CAP ASSEMBLY INSPECTION

PROCEDURES: 4) Fine Leak Test (RE: Engineering Standard P6023)

Mount item on appropriate fixture and sniffle with helium for at least 10 seconds. Parts must not allow a leak rate above 1×10^{-8} cc/sec.

For accepted batches, forward parts and materials to incoming stockroom. For rejected batches, complete one set of Material Review Forms (#5258-2/70 (4) and store material in quarantine area with a M.R. form attached (#9191-5/72) pending decision on disposition by the M.R.B. After decision, forward one copy to project manager, one copy to manufacturing manager, one copy to Q.C. manager, and attache one copy to the incoming inspection card. Identify M.R.B. number on batch containers and M.R. form, dispose of material as instructed.

315

RCA Electro Optics

Specification QP-0027

Quality Control Procedures

Subject WIRE BOND INSPECTION

Issue		Issue		Issue		Issue	
0	May 25, 1973						

SAMPLING: Inspect 100%
Ref. Engineering Standards P4006-P4007

NOTE: Pull Test carried out only on dummy header assemblies.

EQUIPMENT:

a) Stereo-Zoom Microscope 30X
b) Wire Bond Tester, Model MET-A
c) Retained Reading Gauge 2.0 - 15 grams
d) Header Holding Fixture
e) Clean Tweezers

PROCEDURE: Using product specifications check for the following:

a) correct wire type and diameter
b) correct bond type (i.e., ultrasonic, ball bond, etc.)
c) correct number of bonds
d) correct slack
e) correct spread of bond
f) correct length of tail
g) correct position of bond on bonding pad.

BOND PULL TEST:

Test bond strength using Wire Bond Tester and by pulling bonds of dummy Header assemblies.

Dummy Header assemblies shall be identical to those of product being bonded and shall have mounted on a chip rejected during the electrical test (Chip Sorting Process) but with metallized areas which are acceptable and not damaged. If not enough electrical rejects are available from Chip Sorting then headers shall have mounted on them a chip with identical metallization to that of the product being bonded.

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BOND PULL TEST: (Cont'd)

Bond Pull Test must be carried out immediately before start of product bonding, that is as soon as operator has completed setting up bonder. Check at least five consecutive bonds, all five checked bonds must pass minimum specified bond strength. If bonds do not pass minimum bond strength, bonder is not properly set-up, inform accordingly Supervisor. Re-check five additional bonds after bonder has been re-set. Proceed thus until bonder is capable of producing acceptable bonds. Read and record bond test results.

Dummy headers may also be introduced, in a random fashion, within the batch of header assemblies. When this is the case operator will stop bonding process immediately after bonding the dummy header assembly, and will request bond pull test of the dummy. If pull test of bond passes minimum specified strength, operator can proceed with bonding process. If bond strength fails to meet minimum strength, then an additional four dummies are bonded and tested.

The bonding process is allowed to continue only if these four additional bond tests pass all minimum bond strength specified.

Failure to pass the minimum bond strength requires that:

a) bonding process be stopped and bonder re-set and re-checked.

b) header assemblies bonded between the dummy assembly which failed the test, and the immediately previous dummy assembly which passed the test, are removed from the batch and rejected.

Rejects shall be referred to Engineering for examination and if feasible, shall be re-bonded.

Record bond pull tests on process control charts.

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RCA Electro Optics

ıality Control Procedures

Specification
QP-0029
Page 1 of 1
Date May 25, 197

Subject SEALING INSPECTION

	Issue		Issue		Issue		Issue
0	May 25,1973 RW						
1	Apr 10,1979 RW						

SAMPLING: Inspection level II, A.Q.L. 4.0 the basis for sampling shall be MIL-STD-105.
On Custom-made product, inspect 100% to applicable drawings.
Ref: Engineering Standard P4010

EQUIPMENT:
a) Veeco Helium leak detector plus standard
b) Package holding fixtures.
c) Microscope binocular 20X
d) Helium pre-bomb station
e) Fluorocarbon bubble tester.

PROCEDURE: On every lot take the amount of samples required and Helium prebomb per specification for custom devices or 60 P.S.I. for 1 hour minimum, air wash and check for fine and gross leaks within 30 minutes after end of prebomb operation.

The fine leak test operation shall be done before the gross leak test.

1) Fine leak : Unless otherwise specified, devices shall be rejected if the measured leak rate exceed 5×10^{-7} cc/sec.

On custom package leak rate as per specification shall be equal to or better than specified.

Plot results on Control Charts.

2) Gross leak : Devices shall be immersed at a minimum depth of 1 inch below the surface of the indicator fluid F.C.43, which is maintained at $110^{\circ}C \pm 5^{\circ}C$.

Leakers will be identified by larger bubbles or a stream of bubbles, the immersion time shall be a minimum of 30 secs.

The precaution shall be taken to have a clean fluorocarbon F.C.43 without observable particles at all times.

- When units are resistance welded, check for uniformity of weld ring all around.
- When units are epoxy sealed, check for uniform application of epoxy.

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RCA Electro Optics

Quality Control Procedures

Specification	Q.P. 0039
Page	1 of 2
Date	February 20,

Subject FIBER OPTICS AND LIGHT PIPE INSPECTION CRITERIA

	Issue		Issue		Issue		Issue
0	[illegible]						
1	[illegible]						

SAMPLING : Inspect on a 100% basis.

EQUIPMENT :

a) Gloves or finger cots.
b) Microscope binocular X7 - X40.
c) Vernier Calipers.
d) Veeco Helium leak detector.

PROCEDURE :

a) For mechanical or metal portion of assembly, apply Q.M. 0015.
b) Light pipes inspect for:
   1) Sum total glass defects except scratches not to exceed 5% in core as per Figure 1.
   2) Sum total cladding defects touching core not to exceed 20° angles as per Figure 1.
   3) No epoxy or foreign material on core.
   4) Sufficient epoxy to retain centering washers where applicable.
   5) Surface finish to be better than 4L on the S-22 microfinish comparator.

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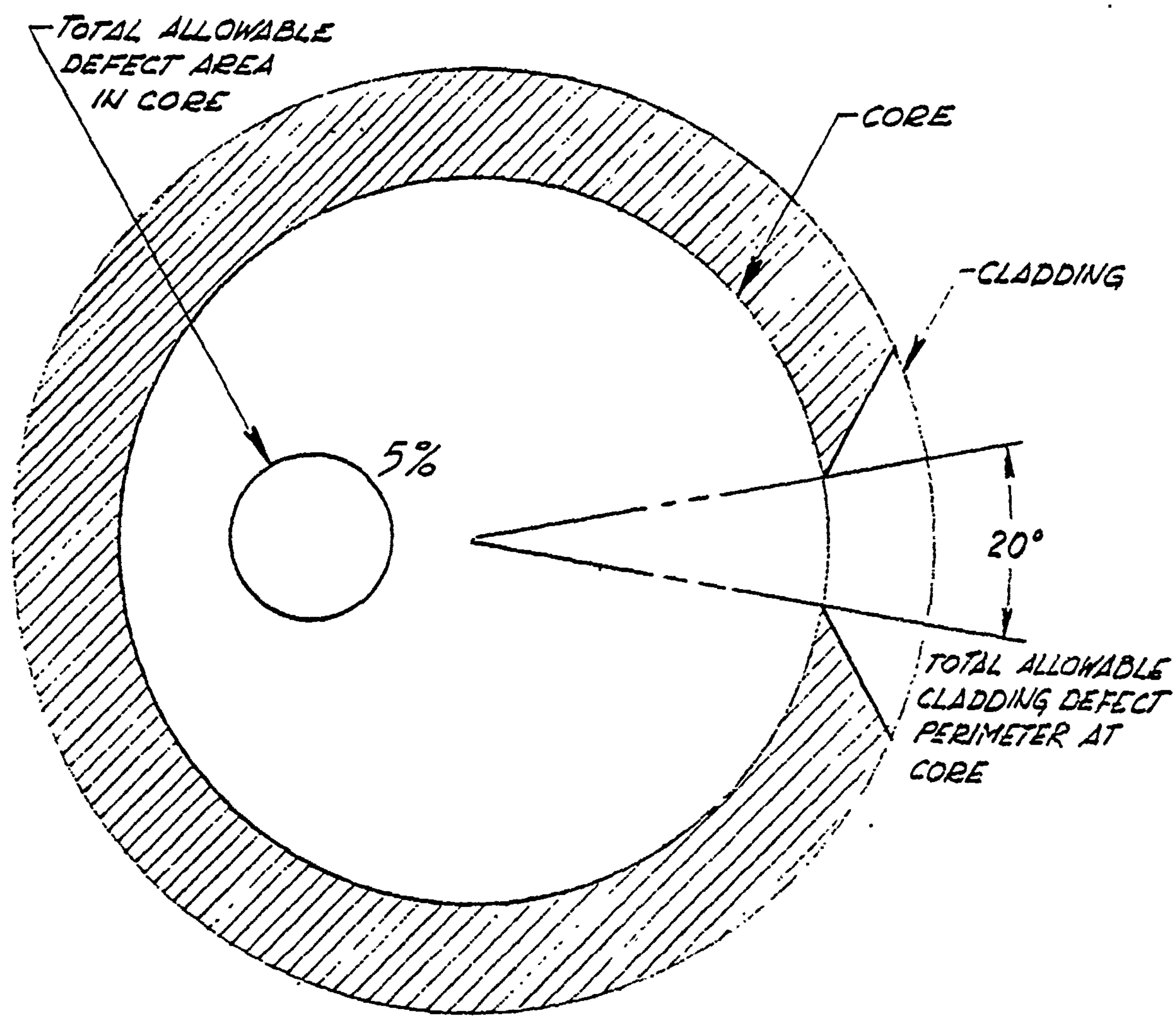
RCA Electro Optics

Quality Control Procedures

Specification Q.P. 0039

Subject FIBER OPTICS AND LIGHT PIPE INSPECTION CRITERIA.

Date Feb. 20, 19



RCA Electro Optics

uality Control Procedures

Specification QP-0041

Page 1 of 1

Subject SPOT WELDED SHIMS OR TABS ON HEADERS, INSPECTION

Date Dec. 19, 1979

	Issue		Issue		Issue		Issue
0	December 19, 1979						

SAMPLING

The basis for sampling shall be MIL-STD-105, Inspection Level II, A.Q.L. 6.5.

EQUIPMENT

a) scalpel
b) gloves or finger cots.

PROCEDURE

Using scalpel, pry shim at weld to test for good weld adhesion.

Do not pry too hard, so as not to distort shim.

Check that there are 5 spot welds minimum on .250 inch diameter shims.

Check that there are no weld marks on back of header.

U.S. CONTRACT #DAAB07-77-C-0489

placed by

U.S.ARMY ELECTRONIC RESEARCH AND DEVELOPMENT COMMAND

ATTN: DELSD-D-PC

FINAL REPORT
MANUFACTURING METHODS AND TECHNOLOGY MEASURE
FABRICATION METHODS FOR LOW COST HYBRID SILICON PHOTODETECTOR MODULES

June 1, 1977 - December 30, 1979

VOLUME III

322

CONTRACTOR: RCA LIMITED
Trans-Canada Highway
Ste-Anne-de-Bellevue
Quebec, Canada

DISTRIBUTION: Limited to U.S.
Government Agencies only

TEST AND
EVALUATION: January 13, 1978

Other requests for this document must be referred to: U.S. Army Communications
Research and Development Command
Fort Monmouth, N.J. 07703
ATTN: DELSD-D-PC

ELECTRO OPTICS

PHOTODETECTORS

QUALITY CONTROL MANUAL

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RCA LIMITED
SOLID STATE DIVISION
STE-ANNE-DE-BELLEVUE
QUEBEC, CANADA

RCA Electro Optics Photodetectors

GENERAL

Section: 1

Quality Program Manual

Subject 1.1 MANUAL SERIALIZATION

Date Dec. 20, 1977

Serial No.

This manual is a controlled copy and is registered with Quality Control.

Copies of all amendments will be forwarded to the person to whom this manual is issued.

All amendments are to be incorporated promptly and the replaced sheets returned to Quality Control.

First issued to: Date:
Title/Location

Reissued to: Date:
Title/Location

Reissued to: Date:
Title/Location

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It is the policy of the Electro Optics Photodetector Department of RCA Limited to build and maintain a reputation for the technical excellence of its products and services and constantly to improve them to ensure the continued satisfaction of customers.

To ensure the achievement of this policy with respect to Government contracts, the department has established and maintains an effective Quality program designed to meet the requirements of DND 1015, "Quality Program requirements for Contractors".

The policy and program described in this document applies to the Government business activities of the Electro Optics Photodetector Department as performed at its facilities at the address below:

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21001 North Service Rd.
Trans Canada Highway
Ste. Anne de Bellevue, Quebec
H9X 3L3

I hereby certify that this manual accurately and adequately describes the system in use within.

RCA Limited Electro Optics Photodetectors Department
21001 North Service Rd.
Trans Canada Highway
Ste. Anne de Bellevue, Québec, H9X 3L3

for the provision of a Quality System to meet the requirements of DND 1015.

R.P. Oorlynck
Manager Quality Control
& Reliability

Dec. 20, 1977
Date

R.G. Power
Manager Electro Optics
Photodetectors Department

21 December 1977
Date

Name of Firm: RCA Limited, Electro Optics Photodetectors Dept.

Address: 21001 North Service Rd.
Trans Canada Highway
Ste.Anne de Bellevue
Quebec, H9X 3L3

Amendment List No.____________________

I hereby certify that this manual has been reviewed and amended as necessary to reflect the current Quality Program.

Section/Pages affected:

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____________________ ____________________

R.P. oorlynck
Manager Quality Control
& Reliability

Date

Evaluated by:

____________________ ____________________

Regional Director
2CF T.S.A. H.Q.

Date

Entered in the Manual:

____________________ ____________________

Signature

Date

Changes which may occur in the organization, policies or procedures of the Electro Optics Photodetector Department are examined by Quality Control and Reliability for the effect on the Government Quality Assurance Program, the accuracy of the Quality Program Manual and the associated procedures. Changes may also be initiated by Quality Control and Reliability to improve the Quality Program plan or to accomodate practices agreed as the result of Quality Program Audits.

The Quality Program Manual is reviewed periodically in the light of such changes and amendments are drafted as necessary to ensure that the manual and the associated procedures remain an accurate description of the current Quality Program.

After review by the appropriate management activity, draft amendments of this document are submitted to DND for approval.

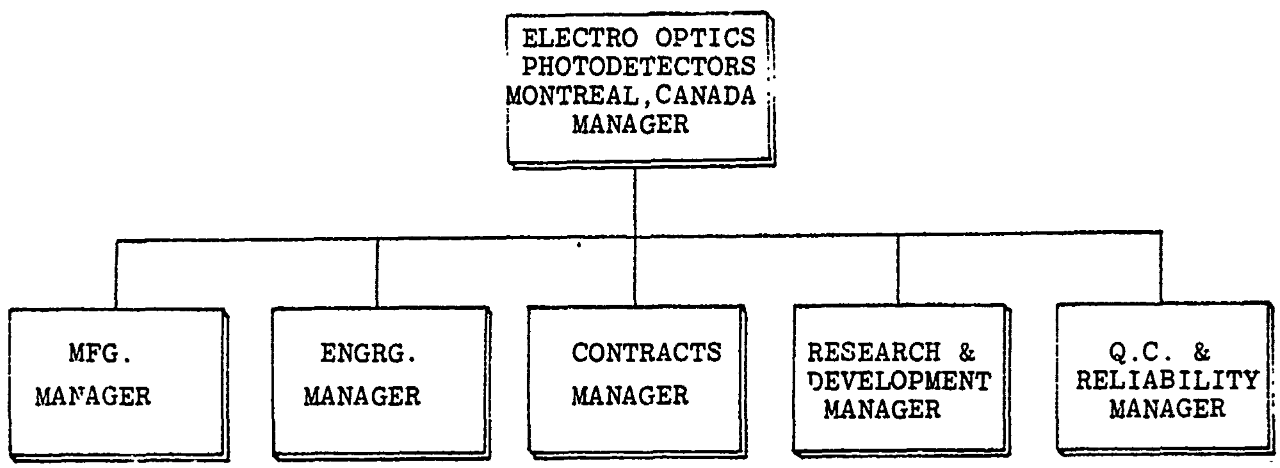
On receipt of the approved amendment certificate, the amended pages are issued to the manual holders (see list attached) and are immediately substituted for the obsolete pages which are returned to Quality Control and Reliability. Each amendment page references the applicable amendment list number.

The Electro Optics Photodetectors Department of RCA Limited (Canada) organization comprises, contracts. engineering, manufacturing, research and development and Quality Control.

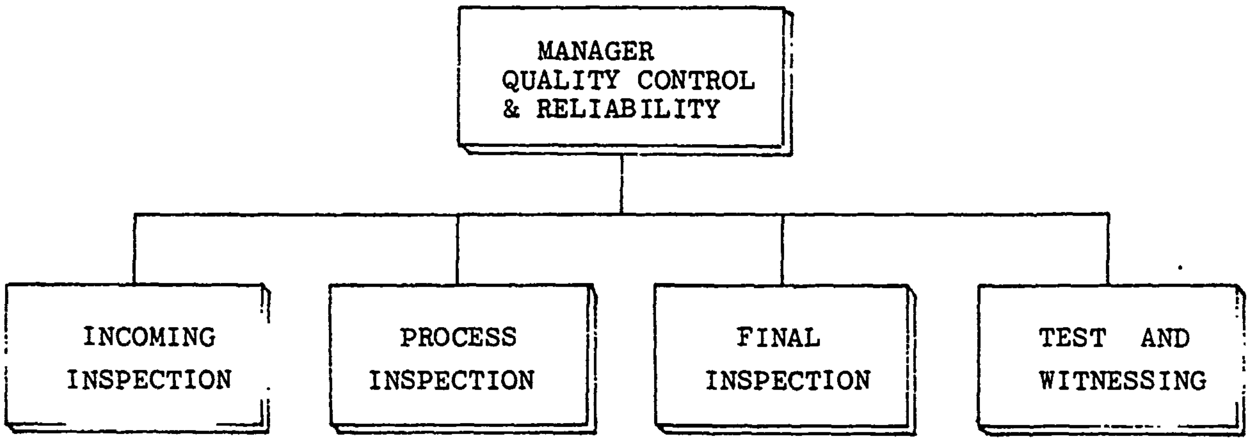
The Organization Chart for the Electro Optics Photodetectors RCA Limited (Canada) is shown on the following page.

The Organization Chart for the Electro Optics Quality Control Department is shown on page 10.

Subject COMPANY MANAGEMENT ORGANIZATION CHART



Subject QUALITY SYSTEM ORGANIZATION CHART



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NOTE:- This is a functional chart only.

Electro Optics Photodetector Department has established a Quality organization as shown in the Chart in Section 2. The Department is authorized to plan and maintain, in conjunction with other management activities, an effective Quality program that assures the implementation of the policies stated in Section 4.

SETTING STANDARDS

Setting of Quality Standards, including the quality requirements on specifications and drawings is the responsibility of Quality Control and Reliability.

APPRAISING CONFORMANCE

Appraising conformance of participating activities to the Quality program as outlined in this manual is the responsibility of Quality Control and Reliability.

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Appraising conformance of product to approved drawings, specifications and Quality Control procedures is the responsibility of Quality Control.

In the case of deviation from the program or non-conformance of the product, Quality Control and Reliability have the authority to ensure corrective action is taken by the Managers responsible or the matter if brought before a material review board.

PLANNING IMPROVEMENTS

Planning improvements to the Quality Program and Quality Control procedures are the responsibility of Quality Control and Reliability.

The policies outlined in this Quality Program Manual are supported by lower tier directives called "Electro Optics General Practices" which are issued, amended under control and made available at point of use through the drawing control system.

These directives establish procedures which control and indicate responsibilities for procurement, incoming, engineering, manufacturing, testing, etc.

The applicable "Electro Optics General Practices" are listed in Appendix A.

A cross reference from Q.C. policies to General Practices is shown by the matrix in Appendix D.

A system for monitoring the extent of compliance to the directives is established through the quality program audits and is performed at least once a year.

Quality Control Procedures are used to check the product conformance, and are controlled and issued by Quality Control.

The Electro Optics Photodetector Department has established and maintains control over all engineering activities. The basis of this system of control is to provide formal engineering drawings and specifications which exclude known incomplete, ambigious or conflicting requirements in drawings and specifications forming part of contract requirements, and to ensure that the engineering data for purchasing or manufacturing reflects and is compatible with requirements of the applicable contract.

The customer is consulted by a system which provides for design reviews prior to the formal release and issue of the engineering drawings and specifications.

Acceptance test and inspection specifications are prepared by Engineering. Test instructions and procedures, for use in production lines, are developed by Engineering and Quality Control.

Deliverable first articles representative of subsequent production are subject to the applicable controls described in this manual (and as appropriate to the contract). Before any acceptance inspection or test of such articles are performed, the DND representative is notified.

The Electro Optics Photodetector Department has established and maintains control of all documents essential to work on Government contracts.

All the latest documents essential to work on government contracts are available at the location when required for production and inspection.

All changes to the essential documents are specified in writing on an authorized Engineering Change Notice (ECN) and are promptly implemented at the specified effective point. A record is maintained of the changes to a given contract as they are made.

Documents shall be revised at the latest when three changes (ECN) have been issued. Written notations on documents are not used as a substitute for authorized change notices and instructions.

Request for changes to Government controlled documents are prepared and submitted as prescribed by the Departmental Representative.

Subject 4.3 WORKMANSHIP

Workmanship is maintained at a level consistent with the technical and functional requirements of the product.

The workmanship standards are controlled by "Electro Optics Engineering Standards" and "Electro Optics Quality Control Procedures" and as defined by production samples inspected and accepted by the contractor and the Government Departmental representative.

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Any material intended for incorporation into a deliverable product, and which is found to be at variance with the contract requirements, is considered to be non-conforming material.

All non-conforming material is identified by means of a red rejection tag, non-conformance and/or Material Review Board Report. Only Quality Control personnel are authorized to remove such identifications and material identified this way cannot be used, shipped, or mixed with conforming material.

Segregation of non-conforming material is carried out whenever possible and quarantine stores are provided for this purpose.

Any decision to perform repair or re-work which results in the item differing from contract requirements, requires the agreement of the DND representative or the unanimous decision of the Material Review Board.

Repair or re-work of non-conforming material may be undertaken provided the repaired article is subjected to Quality Control inspection and accepted by the Government DND representative.

Records are kept of all cases of apparent non-conformance and are maintained as part of the Quality records.

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Quality Control advise of the existence of non-conforming material requiring review. Subject to the DND representative or customer approval, Quality Control requests the Board to convene.

The material review board consists of three authorized voting members representing Quality Control, Engineering and the DND representative/or customer. Other personnel may be called upon in an advisory or consulting capacity but have no vote in the decision of the Board.

Copies of the appropriate form listing the deficiencies found are prepared by Quality Control. One copy of the form accompanies the non-conforming material until such time a unanimous decision is made by the Board members as to the disposition of the material.

The disposition is validated by the signed concurrence of the appropriate members of the Board.

The records of the Material Review Board are reviewed periodically by Quality Control to determine the effectiveness and possible need for improvement in the Quality Control procedures. The frequency of review is determined by the volume and nature of defects submitted to the Material Review Board.

Sub-contractors Material Review, if so authorized by Electro Optics Photodetector Department and the DND representative or customer are subject to final approval by both parties at the Electro Optics Photodetector Departments facility.

Statistical methods of Quality Control including sampling inspection are used whenever advantageous in maintaining effective control of product quality.

MIL-STD-105 sampling plans or 100% inspection is used as marked and authorized on incoming inspection cards and procedures. Material awaiting the required inspection, or receipt of documentation, is withheld from use.

Sampling inspection is not used to eliminate final inspection, but may be used to reduce final inspection providing the statistical techniques used and the application are satisfactory to the DND representative.

Quality control indicates the status of inspection on products inspected, tested or witnessed by them by stamping the identification cards or batch sheets with an inked rubber stamp.

The acceptance stamp is diamond shaped and carries the departments name and a number identifying the inspector. Only acceptable materials are stamped.

The stamp illustrated below is the type currently used by the Quality Control Activity.

The issue of stamps is regulated by means of a register under the control of the Quality Control Manager.

This registry of stamp holders is maintained in the Quality Control office. The registry records the date of issue, stamp imprint and the signature of the stamp holder and date returned.

Personnel are obliged to report misplaced stamps immediately to their supervisor. This condition is recorded in the registry.

Batching is the system used in the Electro Optics Photodetector Department for identifying and record keeping. Whereby an item can be traced back from the end product through all of the manufacturing processes to the source material stage.

The batch system and batch sheets on Government contracts are prepared by Electro Optics Photodetector Department and submitted to the DND representative for review and approval. The batching records are treated as Quality records.

The Electro Optics Photodetector Department has established and maintains a system for identifying, preserving, segregating and handling all material for use on Government contracts from the time of its receipt through the entire production process.

The system includes methods of handling that prevent abuse, misuse, damage or deterioration of material.

Secure storage areas or stock rooms are provided to isolate and protect material pending use.

Limited shelf life items are identified and controlled.

Time expired material is quarantined until acceptability is established or an authorization for disposition is obtained.

Material which is identified as accepted for manufacture or shipping is held in storage areas with limited access.

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Subject 4.9 QUALITY RECORDS

The Electro Optics Photodetector Department maintains quality records as objective evidence of conformance to quality requirements of contracts. These records are available to the DND representative for analysis and review. They consist of:-

- Incoming Inspection Cards
- Inspection and Test Records
- Non-Conformance and Material Review Records
- Quality Program Audit Records
- Batching Records

The incoming inspection cards identify the supplier, the item by part number and name, the applicable QC procedure, the specific inspection together with tests performed and the results obtained. Where the recording of detailed results is not practical the cards include as a minimum the number of non conforming items and the nature of the defects found.

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The inspection and test records identify the item, the applicable requirements, the specific inspections, test performed and the results obtained. Where the recording of detailed results is not practical, the records include as a minimum the number of non-conforming items.

Non-Conformance and material review records identify the nature of the Non-Conformance and record the disposition of the material. They also include the corrective action taken to prevent re-occurrence where practical.

Quality program audit records identify the activity audited, the date of the audit and the results obtained.

In the event of deviations from the program and the associated procedures, records are kept of the feed-back information and the remedial action taken. Re-audits are recorded in the same manner as original audits.

Batch forms identify the item and all materials used to produce the item. They also indicate the acceptance or non-conformance of items.

Unless otherwise specified in the contract Quality, records are retained for at least three years, after the delivery of the items to which they relate.

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The Electro Optics Photodetector Department provides and maintains suitable inspection and test equipment for product acceptance purposes.

Instrument Calibration is maintained by using laboratories recognized by DND.

This laboratory checks and calibrates all equipment before being placed into service, denotes calibration approval. The due date for next calibration which is assigned after consultation with RCA Q.C. and Rel., is displayed on the equipment.

A schedule is maintained of inspection equipment maintenance, and records of calibration history are properly compiled and maintained.

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To ensure that all purchased material and services conform to contract requirements the following controls are exercised.

Selection of Suppliers:

Companies will be considered suitable as new suppliers by the purchasing activities on the basis of reputation, financial stability, price and delivery.

New suppliers are assessed by scrutiny of statements made by them; where appropriate, a survey visit is made to verify such statements before the supplier is selected.

The selection of established suppliers is based on their demonstrated capability to perform.

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Procurement Documentation

The following requirements are included in the purchase orders as applicable:-

a) The Government contract reference number, Electro Optics Photodetectors name and address, the suppliers name and address, and complete shipping instructions.

b) A clear description of the material ordered, including where applicable; drawings, specifications, process requirements, quality assurance requirements, and other relevant technical data such as reference MIL Specifications.

c) Requirements for objective evidence of the inspection performed. Requirements for batching or similar identification to ensure traceability to source.

Amendments to purchase orders bear the same numbers as the original purchase order and are processed in the same manner.

Government Quality Assurance at Source

The DND representative is given the opportunity to request Government Quality Assurance at any suppliers plant. In such cases the purchase order is annotated by the purchasing activity as follows :-

> "Government Quality Assurance at source is required. Upon receipt of this order, promptly notify the government representative who normally services your plant so that appropriate planning for Government Quality Assurance can be accomplished".

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The Electro Optics Photodetector Department is responsible for providing acceptable material regardless of any assurance of Quality provided by the Government.

Supplier Quality Performance

Incoming Inspection vendor cards provide the means for assessing supplier quality performance.

Incoming material for use on government contracts and product lines is identified and inspected to drawings and specifications referenced on the Purchase Order. Upon receipt of non-conforming material, material review action is initiated, and a request for corrective action is sent to the supplier.

Production and assembly within the Electro Optics Photodetector Department is carried out under the control of a Manufacturing Manager. This activity is responsible for the planning and control of in-plant production and the use of manpower, facilities and processes such that the product meets the Quality Requirements of the contract. These requirements are contained in drawings and specifications approved and released by authorized members of the Engineering Department and quality instruction released and approved by Quality Control. Further control of the product Quality is assured by inspections and test performed or witnessed by Quality Control.

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Subject 4.13 FINAL INSPECTION

The Quality Control group subjects all material to final inspection to ensure that contract requirements are met. Quality Control ensures that all inspections and tests shown on the inspection plan are performed, and that all inspection records including test data are made available for the DND inspector prior to submission for Government acceptance.

Subject 4.14 PACKAGING AND SHIPPING

The Electro Optics Photodetector Department establishes and maintains control of packaging and shipping and is responsible that the contract requirements for packing and shipping are met.

Where requirements exist for inspection or test to verify the adequacy of the packaging to be performed, Quality Control either perform or witness such inspections and tests.

The Electro Optics Photodetector Department establishes and maintains an audit system to ensure the effectiveness of its quality program.

Each function of the department contributing to the program is audited at least once a year.

Records of all audits are maintained and analyzed, so corrective action to improve on the system may be taken if necessary.

Inspection plans are prepared for each government contract or product line. A copy of the plan is provided to the DND representative before inspection begins.

The inspection plan contains:-

1. Reference to a schedule which outlines the anticipated dates of inspection and test and the quantity to be produced.

2. A flow chart, or description which indicates at which point in the production process inspection and tests are performed to ensure conformance to the contractual requirements.

3. An indication of the type and nature of the inspection and tests performed at each operation. Detailed inspection and test instructions relating to these operations are available at the inspection and test position prior to the commencement of inspection/test.

The planning of inspection and tests including the preparation of detailed instructions for visual/mechanical inspections are the responsibility of Quality Control.

The Flow Chart and procedures for tests are prepared by the Engineering activity.

The preparation and provision of contractual inspection plans, based on information provided, are the responsibility of Quality Control.

RCA Limited Solid State Division Ste. Anne de Bellevue, Quebec

RCA Electro Optics Photodetectors

Section: Appendix A

Quality Program Manual

Page 32 of 35

Subject GENERAL PRACTICES APPLICABLE TO THE QUALITY PROGRAM PLAN.

Date Dec. 20, 1977

7000	General
7001	Reliability and Quality Assurance Statement
7002	Engineering General
7003	Engineering Drawings and Control
7004	Quality Program Audits
7005	Quality Control Notice
7006	Quality Control Incoming Inspection
7007	Quality Control in Process
7008	Quality Control Test
7009	Lab Rules and Practices
7010	Quality Control Final Inspection
7011	Non-Conforming Material and Material Review
7012	Care of Company owned tools and equipment
7013	Instrument Control
7014	Maintenance and Calibration of equipment
7015	Assembly Operation
7016	Chip Fabrication
7017	Operator Training Program
7018	Material Control
7019	Stores
7020	Purchasing
7021	Workmanship
7022	Packing and Shipping
7023	Scrap Procedure
7024	Returned product for analysis

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Subject LIST OF FORMS USED

1. Engineering Notice
2. Engineering Change Notice
3. Purchase Requisition
4. Purchase Order
5. Purchase Order Change
6. Receiving Slip
7. Stock Card
8. Incoming Inspection Vendor Record
9. Material Review Report
10. Material Review Tag
11. Move Ticket
12. Shipping Order
13. Quality Control Notice
14. Quality Control Ticket
15. Certificate of Compliance
16. Drawing Registration Form

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RCA Electro Optics Photodetectors

Quality Program Manual

Section: APPENDIX D

Date December 20

Subject: CROSS REFERENCE Q.C. POLICIES TO GENERAL PRACTICES

4.15 Quality Audits	4.14 Packaging and Shipping	4.13 Final Inspection	4.12 Production & Assembly	4.11 Purchasing	4.10 Inspection Equipment	4.9 Quality Records	4.8 Control of Material	4.7 Batching	4.6 Inspection Status	4.5 Statistical Techniques	4.4 Non-Conforming Material	4.3 Workmanship	4.2 Documentation	4.1 Engineering	
															7000 General
															7001 Reliability and Quality Ass. Sk.
														X	7002 Engineering General
								X					X		7003 Engineering Drawings and Control
X						X									7004 Quality Program Audits
						X									7005 Quality Control Notice
				X					X	X					7006 Quality Control Incoming Inspect.
								X	X	X					7007 Quality Control In Process
		X							X						7008 Quality Control Test
															7009 Lab Rules and Practices
		X							X						7010 Quality Control Final Inspection
											X				7011 Non-Conforming Material and M.R.
							X								7012 Care of Company Owned Tools,etc.
					X										7013 Instrument Control
					X										7014 Maintenance and Cal. of Equip.
			X					X							7015 Assembly Operation
			X					X							7016 Chip Fabrication
															7017 Operator Training Program
							X								7018 Material Control
							X								7019 Stores
				X											7020 Purchasing
												X			7021 Workmanship
	X														7022 Packing and Shipping
															7023 Scrap Procedure
															7024 Returned Product for Analysis

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